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In this issue is begun a description of the remarkable high-speed electric railway experiments recently conducted on the military railroad between Marienfelde and Zossen in Germany. The unusual sources of information possessed by the author, Signor E. Bignami, and the fine and numerous illustrations which accompany this and succeeding numbers of this paper, make it of special interest and constitute it the most complete and thorough description of this important work that has yet appeared in the English language.

THE ORGANIZATION OF A FACTORY.

Like nearly everything else with which we are familiar, the factory is a product of organic evolution and development. Its history is deeply interesting. In the days of the old handicrafts of shoemaker and weaver, of blacksmith and goldsmith, of carpenter and dyer, workmen lived to themselves or, in cities, gathered sometimes into quarters convenient to each other, being attracted together by the cohesion of common interests. The idea of cooperative works seems to have been introduced into England only late in the eighteenth century. It was evidently convenient for manufacturers of nails, for example, of bolts, of weapons and such things as are made of iron, to locate themselves near smelting furnaces and mines and thither drifted a certain number of craftsmen attracted by cheap raw material. The cotton-spinning industry began soon to adopt machinery. Even, however, so lately as one hundred years ago, milling was a distributed industry, each country district having its grist-mill to which the neighbors brought their grain and from which they carried away the meal and flour. Two factors necessary to the outgrowth of the cooperative system of production had yet to be devised; these were transportation and mechanical motive powers.

The invention of the steam engine brought both. It was found that much of the manual labor incident to the production of cloth and of metal objects could be done by the engine and, in order better to avail themselves of this new power, manufacturers consolidated workmen into groups or factories and thus inaugurated the system of factory production which, carried to its extreme, has marked the present era with its most distinguished characteristic.

The first factories were simply assemblages of workmen. Each man was skilled in all the details of operations necessary for the production of whatever was manufactured there. The engine and waterwheel furnished part of the brute labor. It was not long, however, before invention produced machine tools whereby many of the processes of work, hitherto depending on human skill and activities, were more swiftly and better accomplished by mechanical means. The invention of the spinning-jenny made possible the establishment of cotton factories on a large scale, wherein a part of the work that had hitherto required many operatives was almost entirely done by machinery. The power loom did the rest. In the industries dealing with metals, engine-driven machinery gradually took the place of that operated by hand or foot-power and enabled larger pieces to be constructed. This condition inevitably invited the design of automatic apparatus intended largely to supplant manual labor.

In the last half of the last century began the remarkable era of invention as applied to the production of machines for making machines. Automatic tools began to be heard of. Lathes were constructed which could turn a gun-stock or a shoe-last complete. Apparatus for the manufacture of nails and screws was devised. Later came other machines, some of them of most remarkable ingenuity and complexity and methods, largely electrical, of distributing power through factories and works and of individualizing tools so that they might best and most quickly accomplish the work required of them. To-day the equipment of a large machine-shop is such as to reduce to the absolute practicable minimum the necessity of hand-work at any stage. From the time the iron ore is dug out of the ground by the steam shovel until the finished product is ready for use, modern methods admit little opportunity for purely hand-craft to be exercised upon it.

But the final, or better, the present stage in the evolution of the factory is that the factory itself has come to be regarded somewhat as a machine tool of gigantic proportions. Factories have largely

specialized and their proper organization to-day involves a study both of product and raw material. Methods of manufacture are closely studied to reduce the number of operations involved, to bring the time required in them to its lowest limit, and jealously to economize power and raw material. Buildings are planned with reference to their contents and become essentially a part of the tool equipment of the works. Auxiliary apparatus for handling and adjusting is introduced at every stage and the progress of the raw material through the works, until it is ready for shipment as the finished product, is made as short and as direct as possible.

From this consideration has grown the most complex science of factory organization. Leaving for the moment out of account the complicated questions involved in adjusting the often conflicting claims of employer and employé, the factory resolves itself into a specialized piece of apparatus constructed for perfectly definite ends. The factory engineer designs a works for the maximum of accomplishment with the minimum of expense and labor, while the works manager studies the intricate questions involved in the just allotment of wages to those engaged in the works.

With the coming of the machine tool came also the system of payment known as "piece-work." This apparently was a just and equitable method, but one that in practice was found to be peculiarly liable to abuse by both parties in interest. Piecework involved invariably close inspection of the finished product for acceptance, while it invariablv invited the employer to cut down the rate of pay per piece so as to bring the wages of the most active men down to a point near the standard of former day-wages. Hence the system, originally founded upon an equitable idea, has led to endless trouble and dispute, and in some of the better class of works both here and abroad has been substantially modified so as better to meet the necessity of the case.

With the questions briefly outlined above it is proposed to deal more fully in these columns from time to time. There is no more fascinating and interesting field for observation and comment than that presented by the constantly changing aspect of manufacturing regarded as a science. Even now it is possible in some directions to note the limit toward which advance and change are tending, and to foresee what may be regarded as the final outcome of experiments in works organization and management.

WEATHER AND TELEGRAPH INTERRUPTIONS.

Last week the middle-eastern states were visited by a very severe sleet-storm accompanied by high winds, with the result that several cities were more or less entirely cut off from communication by telegraph with the remainder of the country. For two days there was no communication with Philadelphia and during most of this time communication between New York and Washington was by mail and messenger. Upon the occasion of the journey of the visiting Prince Henry of Prussia to Washington, it was only with the most extreme difficulty that a telegraph line could be connected between Philadelphia and Washington for the proper handling of the train-despatchers' work while the royal guest was *en route*.

The fact that nothing particularly serious, beyond vexatious delay to newspapers and general business and the total suppression of the weather reports, grew out of this state of things is not to be taken as an argument that something serious may not happen unless measures are taken to render such an occurrence impossible. The fact that the capital city of the nation and its commercial metropolis could be for two days put practically out of touch with one another is entirely too serious to admit of argument. What is needed to be done is what has already been done in England—the construction of an underground line of telegraph cables connecting the important financial, commercial and governmental centres of the country.

While doubtless the first cost of complete system of subterranean cables would be large, it does not seem reasonable to suppose that such cables would not pay and pay handsomely. The loss of revenue to telegraph companies together with the expenditures entailed by the recent sleet-storm were sufficiently great to have gone a considerable way toward paying for the underground line. On such a line experience in England has shown that maintenance cost is practically negligible. The construction of a main artery of the telegraph service in Great Britain in this manner was undertaken several years ago, after a severe storm had greatly damaged the telegraph wires in that country and temporarily suspended communication between its important centres of activity. The line was laid between London and Birmingham and Manchester and consists of a multiple-circuit cable laid in an iron pipe conduit and brought up at intervals to test-boxes mounted on iron pillars which form convenient points for testing, splicing and renewals. Figures of the cost of this enterprise are not at hand, but it is certain that it has already been worth many times its cost to the commercial community, if not to the government of Great Britain. In this country, with its great distances, the cost of such construction would naturally be higher, but the interests at stake and which may be menaced by even momentary interruption of telegraph and telephone communication are too great for a matter of cost to stand long in the way.

The interesting question here rises as to whether a similar construction could not now be applied to telephone circuits of great importance. The brilliant work of Professor Pupin has made it possible now to talk over cables of any reasonable length, and no doubt a telephone line between New York and Washington, or even New York and Chicago, could even now be operated through underground cables. Whether this be done or not, however, there is no denying the necessity for such telegraph lines. They must be had, and promptly. If the storm of last week had come at a time of intense political excitement or perhaps when the country was at war, the damage done might have been simply incalculable.

The article concerning the metric system by Charles T. Porter, which appears on another page, is marked by a considerable measure of plain common sense. He puts the case for the English system most forcibly in a very few words, and his remarks are commended to the attention of those who believe the metric system is "scientific" because it happens to be difficult.

ELECTROCHEMISTRY.

The meeting of the Institute of Electrical Engineers held Friday evening, February 28, gave occasion for the presentation of a number of papers of much more than usual interest. The subject of the evening's programme was "Electrochemistry and Electrometallurgy" and seven papers of unusual value were read in abstract, as is more fully stated in another part of this issue. Perhaps the most interesting phase of the meeting and papers was the exhibition given in them of the great and growing importance of electrochemical processes. Curiously enough an electrochemical process was one of the very first industrial applications of electricity. Electroplating is an art now nearly seventy years old, and electrotyping is but little younger. For many years, however, the advance of this department of applied electricity was small. Even after the invention of the dynamo had given a source of powerful and cheap electric currents little use was made of their chemical actions for several years. Of late, however, there has been a great and constantly increasing exploitation to this branch of electrical engineering, and to-day it is taking its place as one of the more important directions of electrical development.

While much the youngest of the great branches of electrical engineering, the chemical applications of the current promise shortly to be ranked among the most valuable uses of electricity. The industries which have already been founded for the utilization for electrochemical processes are numerous and rapidly increasing. In the paper by Dr. Samuel Sheldon, reprinted elsewhere in this issue, is given a considerable list of such enterprises in the United States alone. Great as this extension of the commercial development of the subject already is, however, the most interesting and probably the most fruitful work that is being done is that of the experimentalists who are endeavoring to discover new processes founded upon electrochemical actions.

When it is considered that results already obtained point definitely to successful methods for combining the nitrogen of the atmosphere, with the resultant production of nitric acid—a basis for food products and fertilizers—one of the most astonishing phases of this subject is encountered. In his presidential address before the Royal Society some years ago, Sir William Crookes first called attention to the potential possibilities of this single direction of electrochemical development. By providing cheap fertilizers the food-producing regions of the world could be very largely increased in number and in output, with the result that a greater population could be borne and social results of the most important and beneficent kind secured. On the other hand, experiments constantly going on in the synthesis of organic compounds have pointed to the possibility of artificially producing such foods as starch and albumen. The imagination is almost staggered before the picture that is presented by this conception.

It is not, however, alone in such directions that electrochemical advance is being made. Already new products of value have been obtained and have formed the bases of new and growing industries. Aluminum has come into competition seriously with other metals in many directions. Calcium carbide has become the basis of considerable industry and seems to be a substance of immense potential activity and usefulness. The list of semi-organic compounds, or compounds of the carbon series, which are now being produced by electrical means is far too long to reproduce here, but among them may be mentioned camphor, which is the basis of celluloid, carbon tetrachloride, which promises to be of great use in the arts as a solvent, and such perfumes as vanillin and dye-stuffs of the aniline series.

These remarkable achievements made in a few years are certainly sufficient to indicate that immense field of activity that is open to the electrochemical investigator. It is fully believed that this subject is yet at the beginning of its career of development and that the future may see the chemical applications of electricity take rank in importance and value equal with the present mechanical and thermal manifestations with which we are familiar.

"CAPTAINS OF INDUSTRY."

One of the most interesting features which distinguished the entertainment of Prince Henry of Prussia in New York recently was a luncheon given to him, at which about one hundred of the men who have done the most to make American industries famous and important were gathered to meet him. Of this number it is interesting to note that no fewer than seventeen were immediately connected with electrical enterprises. Of this number, six were past presidents of the Institute of Electrical Engineers and ten were members of that body. The full list is given elsewhere in this issue.

Among the electrical men present were founders of the industries of arc lighting, incandescent lighting, central station distribution, the polyphase transmission of power, the electric street railway, a variety of electrochemical processes, the inventors of the telephone and of the greatest improvement in the art of telephony, the inventor of practical electrical measuring instruments, and representatives of the largest institutions for manufacturing electrical apparatus, for utilizing electrical power for railways, for signaling and for other processes, and the largest institutions of learning for electrical engineering in the world. Surely, no other country could make such a showing.

The long paper by Mr. Percy H. Thomas, concluded in this number, which was read before the recent special meeting of the American Institute of Electrical Engineers, deals with a subject of no little importance and gives an apparent solution for the troubles due to the static disturbances on high-tension transmission lines. The author places in series with the apparatus to be protected, generally a transformer, a reactance coil and connects a point between this coil and the instruments to be protected with the ground through a condenser. It is unfortunate that the author did not explain what he regards as the necessity for any special construction to accomplish this purpose. The external turns upon the primary winding of a transformer constitute precisely the kind of coil required, and all that is apparently necessary to put his system into effect is to connect some point of this winding through a suitable condenser to the ground. Both condenser and connection might well be included within the case of the transformer, thus constituting a self-protecting instrument.

Science Brevities

A Sensitive Vacuum Discharge—It is not absolutely necessary to use the Tesla apparatus, according to an abstract in the *Electrician* by Mr. D'Albe, to obtain a luminous discharge which is very sensitive to external influences. W. B. von Czudnochowski describes one which is obtained by very simple means. He uses a vacuum tube consisting of two spheres six cm. in diameter, joined by a tube twelve cm. long and one cm. in diameter. The spheres contain a cathode each, placed so that the rays are at right angles to the connecting tube. One of the cathodes is plain, while the other is concave. The anode is contained in a side tube attached to the middle of the connecting tube. When both cathodes are working in parallel the whole connecting tube is filled with positive light. But at a certain exhaustion one-half of the connected tube becomes dark, while the other remains alight, the whole discharge passing through the plane cathode. If at this stage the sphere containing the concave cathode is touched with the finger, the whole discharge jumps across into the neighboring portions of the connecting tube and returns as soon as the finger is removed. After further exhaustion the same thing happens when the observer merely approaches within a couple of yards, but the sensitive state disappears on still further exhaustion.

Electrolytic Oxygen and Hydrogen—The London *Electrical Engineer* quotes the description of an apparatus from the *Zeitschrift fuer Electrochemie,* which is being manufactured by the Elektricitäts-Gesellschaft (formerly Schuckert & Company) for the commercial production of oxygen and hydrogen by means of electrolysis. The capital cost of an installation composed of 40 elements and capable of producing 100 cubic metres of oxygen and 200 cubic metres of hydrogen in 24 hours is given at £900, the daily expenses at £3 1s. 3d. A solution of 15 per cent of caustic soda in 85 per cent of water is used, and 2.8 to 3 volts per element is required. The water must be maintained at 70 degrees centigrade. If steam is available, some saving in electric energy is made, as part of the power is otherwise lost in heating the water up to 70 degrees centigrade. The electric conductors are made of copper; the rest of the apparatus (retorts and reservoirs) is made of cast iron. The two gases coming from the two electrodes are gathered in separate vessels connected by india-rubber tube receptacles, where the last traces of the soda are washed out. Thus oxygen and hydrogen of a purity of from 97 to 98 per cent is obtained. The apparatus designed by the above-mentioned company has the following over-all dimensions: 2 feet 2¼ inches by 1 foot 6 inches, and 1 foot 3 inches high. It contains 40 litres of soda solution, and takes a current of 600 amperes. The production of gas per hour obtained with this apparatus is 220 litres of hydrogen and 110 litres of oxygen at atmospheric pressure, and at 15 degrees centigrade. Forty such cells connected together are able to turn out some 200 cubic metres of hydrogen and 100 cubic metres of oxygen in twenty-four hours. The cost of the apparatus works out at about £900, and, with energy costing 0.575d. per kilowatt-hour, the actual cost of the gas, including working expenses and interest and depreciation at 15 per cent, comes out at about 2.4d. per cubic metre. If the gas has to be compressed into iron tubes for commercial purposes, of course, the cost will assume a slightly higher figure.

Aluminum Alloys—Léon Gillet, in recent numbers of *Comptes Rendus,* 1901, has been repeating and extending the work of Le Chatelier and Gautier on the alloys of Al with Cu and Sn. The *Electrical Times* (London) quotes as follows: He has isolated in a pure state and physically examined the compound Cu_3Al, CuAl, Al_2Cu; also Al_4Sn and AlSn; they all crystallize very distinctly and have some peculiar properties. In determining the tin by Classen's method of dissolving in hydrochloric acid with the aid of a little nitric, neutralizing with ammonia, adding ammonium oxalate and electrolyzing at about sixty degrees centigrade, it was necessary to work with dilute warm solutions, or the tin would be deposited as a little-adherent black powder. There seemed to be a formation of a superficial tin-platinum alloy, as the electrodes were very difficult to clean, and even sometimes required fusion with bisulphate of potash. The writer has repeatedly noticed this phenomenon, which is an inconvenience of many electrolytic separations.

Sodium from Fused Nitrates—The January issue of the *Journal* of the Franklin Institute discloses the fact that the John Scott legacy premium and medal have been awarded to Mr. James D. Darling for his inventions in connection with the electrolytic production of metals and nitric acids from fused nitrates. A committee of the Franklin Institute has thoroughly looked into Mr. Darling's inventions, and its report is of great interest as showing the actual progress made by the inventor in overcoming the serious difficulties in the electrolization of fused nitrates. The committee remarks that when going over the plant, which is now in working operation, it was able to see from the remains of former types the energy which Mr. Darling has shown in following up his invention. In the same number of the *Journal* this inventor gives a full description of his latest apparatus. He found, after experimenting, that it was necessary to have a complete separation between the fused nitrates and sodium ions. In order that this could be done, he introduced into his apparatus a porous diaphragm, which is able to withstand the destructive fluxing action of the electrolyte. This he makes of a mass of vitrified magnesium oxide confined between two walls of perforated sheet iron. The porous cup thus made is thirty inches in height and sixteen inches outside diameter, and has walls four inches thick, which leaves the inside diameter of the cup eight inches. The rest of the furnace consists of a cast-iron pot which holds the fused nitrates and acts as an anode. The inside of the porous cup is filled with fused sodium hydroxide. In starting up the furnace the pots have to be heated until the nitrates are fused, but after that the heat generated by the passage of the current is sufficient to keep the solution in a liquid state. Hydrogen dioxide and oxygen are liberated as gases at the positive electrodes, and are collected and made into nitric acid in the usual way. The first sodium liberated is absorbed, to a certain extent, by the sodium hydroxide, hydrogen gas being evolved and sodium monoxide probably formed. After some time, however, sodium rises to the top of the electrolyte, and is skinned off with a spoon about once an hour. In order to prevent the perforated iron walls of the porous cup being eaten away, about five per cent of the current is shunted through them so as to make them positive. This plan has reduced the local action between the electrolytes and this iron and increased its life about ten times. Each furnace as now constructed takes about 400 amperes at 15 volts, and the life of the cups is from 425 to 450 hours. The committee in its report alludes to the fact that the high resistance of the porous diaphragm makes the process somewhat expensive as regards electrical energy. It will be seen that fifteen volts is required, which is much higher than the decomposing voltage of the sodium nitrate. We are pleased to note that Mr. Darling is working on a commercial scale, as the process is one which will be of great value where water power is cheap.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LIX.

BY W. ELWELL GOLDSBOROUGH.

Example 25.

Given: A 100-kilowatt alternator, developing 1,000 volts at 60 cycles. The ohmic resistance of the armature is 1 ohm; the inductance of the armature is 0.01062 henry. The synchronous reactance of the armature will, therefore, be 4 ohms.

Determine the characteristics of this machine when it is operated under a variable inductive load, having a constant resistance of 8.16 ohms.

In proceeding with the solution of this problem, we will first construct the vector diagram representing the balance of forces in the system when the armature is impressed upon the external circuit, free of inductance. Since, then, x_1 in this case equals zero, we can lay off in Fig. 142 the vector OA_0, equal to the total internal electro-motive force developed in the armature; then, since

$$I^a = \frac{E_0}{\sqrt{(r_a + r_1)^2 + x_a^2}} = 100 \text{ amperes}, \quad (54)$$

and

$$\phi_0 = \tan^{-1} \frac{x_a}{r_a + r_1} = 23^\circ\ 35', \quad (55)$$

we can lay off the electro-motive-force triangle $OC_0{}^aA_0$, in which $OC_0{}^a$ equals $I^a(r_a + r_1) = 916$ volts, and $C_0{}^aA_0 = I^a x_a = 400$ volts. Then, the current vector OB^a (equal to 100 amperes) can be laid off in phase with $OC_0{}^a$. Also, the armature resistance electro-motive force $OC_a{}^a = 100$ ohms can be laid off in phase with OB^a, and on it the impedance triangle $OC_a{}^aA_a{}^a$ erected, in which $C_a{}^aA_a{}^a$ equals the armature reactance electro-motive force, and $OA_a{}^a$ equals the armature impedance electro-motive force equals 412 volts.

Now, measuring the distance between $A_a{}^a$ and A_0, we find that the collector electro-motive force initially equals 816 volts.

To determine the strength of the field set up by the armature currents, we must lay off the vector OM_0, equal to the total field flux included by an armature coil; then, parallel to the vector OB^a, we must lay off the vector M_0M^a, giving it a length determined by the proportion

$$OM_0 : M_0M^a :: OA_0 : C_0{}^aA_0.$$

That this proportion holds true necessarily follows from the fact that the reactive electro-motive force $C_0{}^aA_0$ is produced by the armature flux M_0M^a.

Suppose, now, that we give to the external reactance, x_1, a value equal to 13.8 ohms, while keeping $r_a = 8.16$ ohms. The new value of the collector electro-motive force, due to the introduction of this inductance into the receiver circuit, is determined by laying off the line $OC_0{}^c$.

$$\phi_0{}^c = \tan^{-1} \frac{4 + 13.8}{1 + 8.16} = 62^\circ\ 44'$$

behind the vector OA_0. $OC_0{}^c = I^c(r_a + r_1) = 458$ volts; therefore, since $r_a + r_1 = 9.16$ ohms, the armature current equals 50 amperes. We can, accordingly, lay off OB^c, giving it this value. Moreover, on $OC_0{}^c$ we can lay off $OC_a{}^c$, equal to 50 volts, and upon it erect the impedance triangle $OC_a{}^cA_a{}^c$, in which $C_a{}^cA_a{}^c = 200$ volts, and $OA_a{}^c = 206$ volts; therefore, $A_a{}^cA_0$ will, in this case, equal the electro-motive force apparent at the collector rings, or 801 volts.

By similar construction, successive values of the collector electro-motive force and the armature currents can be determined. Calculations have been so made, and are recorded in table 19, in which x_1 is successively given the values tabulated in the right-hand column of table 19. The phase positions attained by the vectors for these value of x_1 are designated both in table and in Fig. 142 by the letters (a), (b), (c), (d), and (e), respectively. To determine the lag of the current behind the total internal electro-motive force, successive values of x_1 are substituted in equation,

$$\phi_0 = \tan^{-1} \frac{x_a + x_1}{r_a + r_1} \quad (55)$$

while, to determine the lag of the current behind the collector electro-motive force, substitution of the successive values of x_1 must be made in equation

$$\phi = \tan^{-1} \frac{x_1}{r_a + r_1} \quad (55)$$

It is, further, to be remembered that the collector electro-motive force is the electro-motive force actually generated in the winding. The value OA_0 is only actually apparent and developed in the coils at no-load, or when x_1 equals ∞.

Taking the data of table 19, and plotting it in rectangular coordinates as abscissa against the values of the currents used as ordinates, the characteristic curves of Fig. 143 are developed. It is well to study these in connection with the curves of Fig. 136, plotted to the same scale, since the former illustrates the performance of an alternator under inductive load, and the latter the performance of an alternator under non-inductive load.

Of Fig. 143, the curve of greatest interest is that showing the variation of the potential at the collector rings. At full load, the electro-motive force at the collector rings is 18.4 per cent less than the no-load electro-motive force, whereas, when the armature current has decreased from 100 amperes to 75 amperes, the collector electro-motive force is 25.5 per cent less than the no-load electro-motive force; or, in passing from full load to the no-load values, there is a dip to 745 volts in the electro-motive force at the collector rings. Nothing like this can ever occur in direct-current working.

SINGLE-PHASE ALTERNATORS UNDER A VARIABLE CAPACITY REACTANCE LOAD.

Having studied the effects of variable resistance and inductance in a receiver circuit upon the operation of a single-phase alternator, we will now consider a third important element, namely, the effect of variable capacity in a receiver circuit. The diagram of Fig. 144 shows the connections which obtain in this case. In taking up the discussion, we will assume, initially, that the capacity is infinite, and gradually reduce it to a zero value, thereby imposing the effect of variable capacity upon a simple non-reactive vector diagram. Initially, then, that part of Fig. 145 which is outlined by the designation letter (a) represents the balance of forces, and the equation of the value of the current is

$$I^a = \frac{E_0}{\sqrt{(r_a + r_1)^2 + \left(\frac{1}{C_1\omega} - L_a\omega\right)^2}} = \frac{E_0}{\sqrt{(r_a + r_1)^2 + (x_1 - x_a)^2}} \quad (155)$$

since, in this case, the reactive factor

$$\frac{1}{C_1\omega} = x_1 = 0,$$

as $C_1 = \infty$ for the (a) position of the vectors.

Now, as the variable capacity diminishes, the reactance of the receiver will increase. The value of the current flowing will, therefore, be subject to change, in accordance with equation (155), and the current vector OB^a will take a new phase position relatively to the total internal electro-motive force OA_0, expressed by equation (156).

$$\phi_0 = \tan^{-1} \frac{\frac{1}{C_1\omega} - L_a\omega}{r_a + r_1} = \tan^{-1} \frac{x_1 - x_a}{r_a + r_1} \quad (156)$$

An electromagnetic gun, invented by Professor Birkeland, has been experimented with at Christiania, and the results were of a very satisfactory nature. The shell is drawn out of the bore, and not, as hitherto, impelled by gunpowder, and the use of magnetism, according to the Professor, will enable 1,000-pound projectiles to be hurled much farther than by the present methods.

The Berlin-Zossen High-Speed Electric Railway Experiments—I.

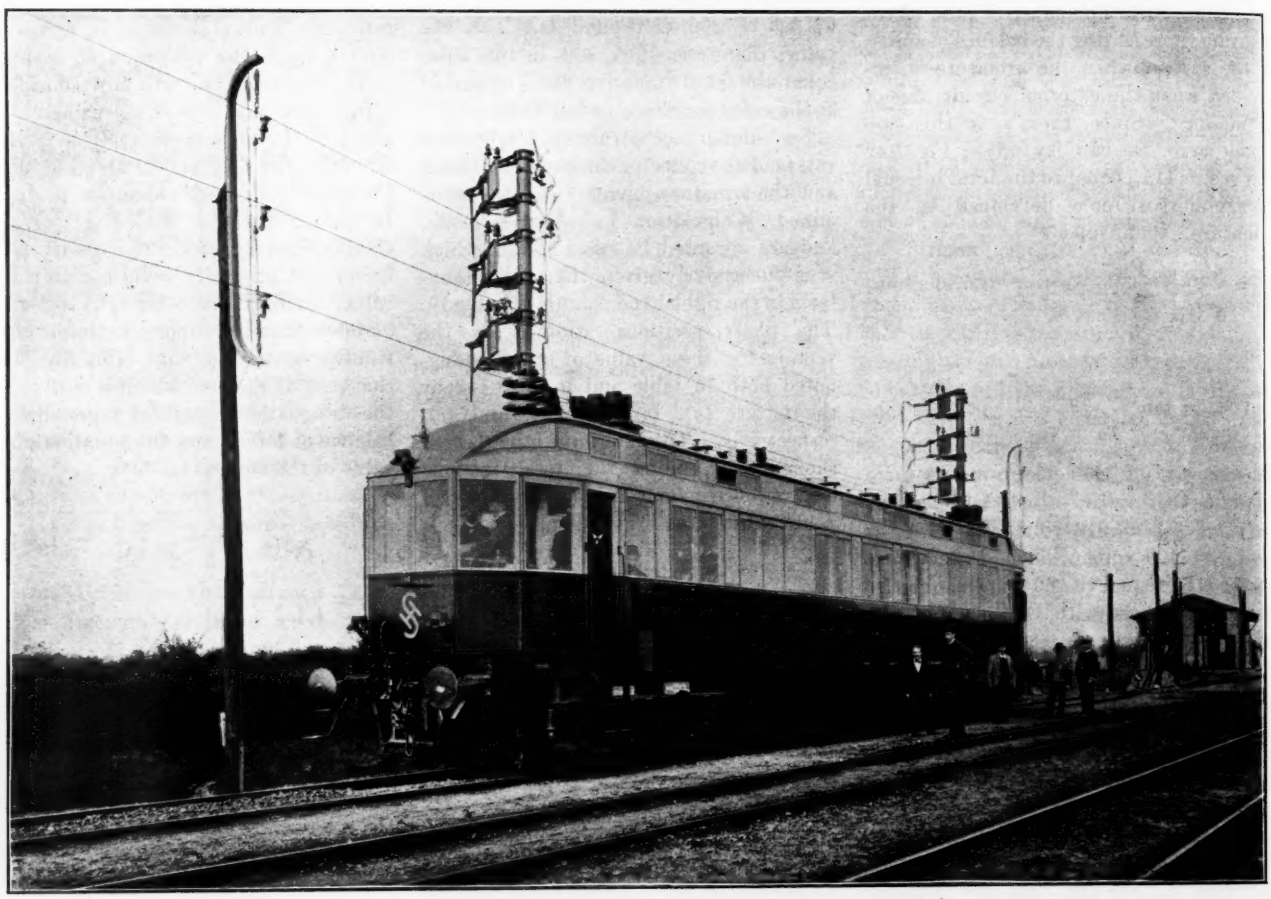
By Enrico Bignami.

IT MAY truthfully be said that the last year was one of unusual progress in Europe in regard to electric traction, even without taking into account the electric tramway lines which, during that time, almost doubled in number.

The same period of time saw the completion of the second year of the exploitation of important accumulator lines (for example, the line from Milan to Monza, fifteen kilometres long, and that from Bilogna to San Felice, forty-three kilometres long). It witnessed also the inauguration of the first section, that from Milan to Varese, of a system of 130 kilometres long, using the third rail, which will be completed within a few months and which will be used both for the transportation of passengers and freight. The same year also saw the tests of the Valtellina system in the north of Italy, using three-phase current of 3,000 volts directly upon the motors and comprising a total of 109 kilometres of track. This line will be opened next month. As already described in the ELECTRICAL REVIEW for August 10, 1901, the conducting system for the later railways comprises two trolley wires, the track rails being used as the third conductor of the three-phase system. On account, however, of disturbances created upon telegraph and telephone lines, it may be forced to adopt the triple aerial conductor system used in the equipment of the Berlin-Zossen line described below.

During the same period the well-known Swiss three-phase road from Burgdorf to Thun, forty kilometres, has been in operation, this road being fed by a primary current of 20,000 volts and using motors working at about 1,000 volts. The third-rail line between Le Fayet and Chamonix in France, at present some nineteen kilometres long but being extended up to the Swiss frontier, was also put to work. It is notable that in this line the method of operating trains is that which has been called by Mr. Sprague, the "multiple unit system." Whatever may be the number of the cars making up the train the control is in the hands of a single motorman on the front platform. The same system is also under construction, using the apparatus of the Thomson-Houston Company at Paris upon one of the lines of the Compagnie de l'Ouest, this also being equipped with a third rail.

Among other applications during the last year should be noticed also the Grenoble line, in France, which is equipped with a double trolley wire for direct current. The tests continued by the Belgian Government on the application of electric traction of railways are also most interesting, as are indeed the important discussions leading up to a choice of systems for the underground and suburban



THE EXPERIMENTAL HIGH-SPEED CAR ON THE MARIENFELDE-ZOSSEN RAILWAY, SHOWING DETAILS OF TROLLEYS, CONDUCTORS, TRACKS AND GENERAL ARRANGEMENT OF THE 140-MILE-AN-HOUR CAR.

railways of London. As is well known, it was decided there to adopt the direct-current system.

But most noteworthy of all are the trials made upon the railway line between Marienfelde and Zossen, in Germany, with electric traction appliances working at very high speeds.

As the readers of the ELECTRICAL REVIEW have been informed from time to time, there was formed at Berlin toward the end of 1899, under the patronage of the government, a company known as the Studiengesellschaft für Elektrische Schnellbahnen, or association for the study of high-speed electric railways. Its precise object was to undertake experiments upon the electrical equipment of railways, particularly from the points of view of the construction of cars, the consumption of energy, problems of track and wind resistance and, in a word, to determine within what limitations electrical exploitation of railway lines could be adapted to the technical and economical conditions of our time. In May, 1900, after several trial trips made by the Siemens & Halske Company upon a section of the line at Gross-Lichterfelde, the Studiengesellschaft decided to adopt the system there tested upon a military railway between Marienfelde, a suburb of Berlin, and Zossen, turned over to them for this purpose by the Prussian Government.

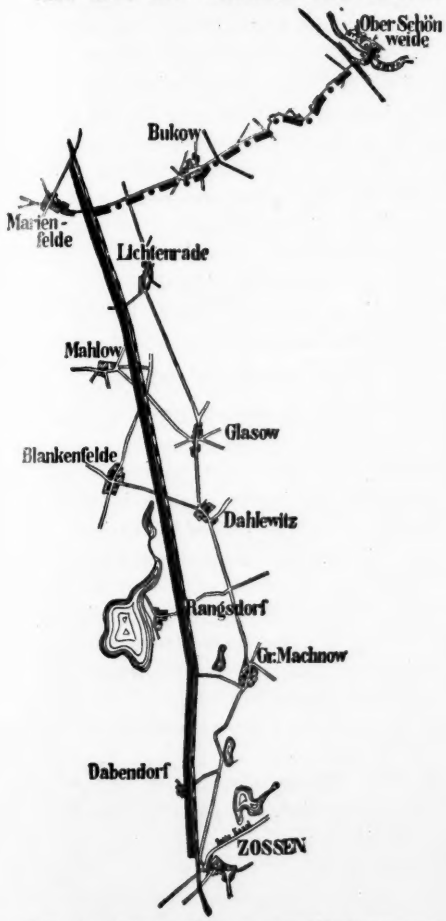


FIG. 1.—SKETCH MAP OF THE MARIENFELDE-ZOSSEN HIGH-SPEED ELECTRIC RAILWAY.

The services of two firms were engaged to carry on the undertaking, that already mentioned, Messrs. Siemens & Halske undertook the construction of the railway system proper, while another well-known company undertook the generation of three-phase current in its power station at Ober-Schöneweide and its transmission to Marienfelde. Two cars were constructed by Messrs. Zypen & Charlier and were equipped electrically, one by the Siemens & Halske Company and the other by the Allgemeine Company in Berlin. The general nature of the line chosen for the experiments is shown in the sketch map Fig. 1.

First of all the programme to be followed was worked out. The line chosen is a single track, of standard gauge, and is laid upon wooden cross-ties and ballasted with cut stone. In all its length is twenty-three kilometres (13.7 miles) and its curves have a minimum radius of about 3,300 feet. The steepest grade is 5.43 per cent.

Cars seating fifty passengers were chosen as a standard type, these being carried upon two trucks, each having three axles, with a maximum weight of sixteen tons per axle complete.

The conducting system is three-phase, of the three-conductor type, and works at from 10,000 to 12,000 volts, forty-five to fifty cycles per second. This tension is nowadays, relatively speaking, low. The working of electric current under 40,000 to 50,000 volts pressure is to-day a matter of custom, and such currents can be sent to great distances without appreciable loss. The problem, however, presented here was as well solved by the use of the lower pressure.

It was planned that the car should be controlled from either end and each car was completely furnished with apparatus for the measurement and control of the current used as well as an outfit of electric lights, the latter being operated by a battery of accumulators.

The purpose of the experiments was to attain speeds of from 200 to 220 kilometres (124 to 138 miles per hour), all of the calculations for the design of the electrical equipment being such that it would be possible to make a round trip of 250 kilometres each way without excessive heating of the motive-power apparatus. It was also necessary in these tests to arrange so that, between the times when the train is accelerating at starting and receiving negative acceleration from the brakes at stopping, a sufficient lapse of time should intervene for the careful measurements which were, after all, the object of the tests. A period of three minutes was selected during which the train would run over about six and one-half miles of track at its normal speed.

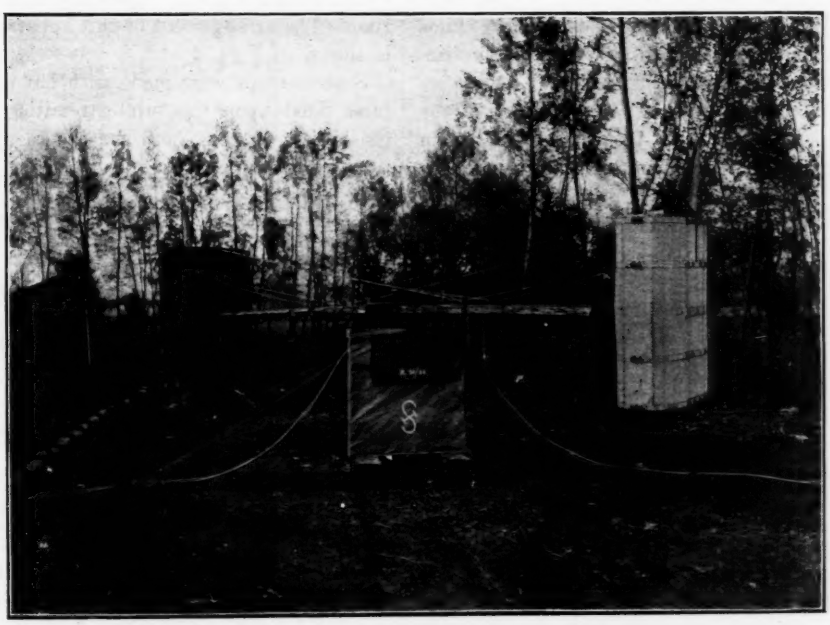


FIG. 2.—APPARATUS FOR DETERMINING AIR RESISTANCE OF TRAIN FRONTS.

POWER ABSORBED.

The first and one of the gravest problems which presented itself to the engineers in charge of this difficult enterprise, was that of obtaining the necessary power to produce the desired results. As the most important factor entering the case

is the air resistance, usually calculated by formulæ appropriate to ordinary speeds and to such train fronts as are in current use, and as these were not applicable to the conditions of the problems, it was necessary to commence at the very beginning by obtaining a new set of data on this point.

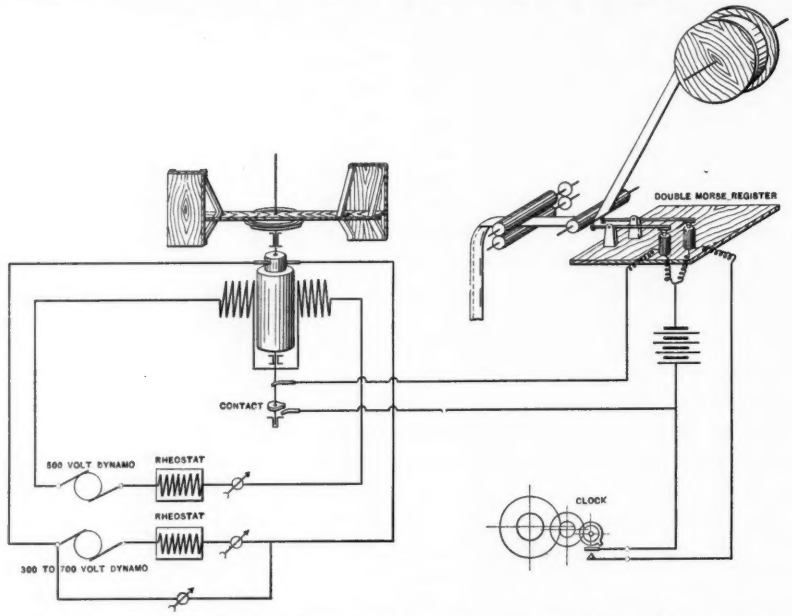


FIG. 3.—ARRANGEMENT OF REGISTERING APPARATUS, BERLIN-ZOSSEN EXPERIMENT.

Abandoning, then, the semi-empirical formulæ of Clark, recourse was had to the rational method, assuming a coefficient of traction resistance of 0.0045 kilogramme per ton to account for the friction of different surfaces, and an air resistance proportional to the square of the speed, calculated from the well-known formula of aerodynamics. Since this coefficient of resistance has a large value for plane resisting surface and is much less for surfaces of other shapes, a series of experiments was undertaken to determine a form better adapted to diminish air resistance. To this end the machine shown in Fig. 2 was constructed, this consisting of a vertical shaft driven by a 200 horse-power separately excited motor, securely anchored to the ground. The rotating part comprised an ordinary tramcar wheel, upon which a horizontal table was rigidly secured, this being about twenty-one feet long and to its extremities being attached the various shapes under trial. For the exact control of the speed in the later experiments a moving strip of paper was arranged to be marked by two Morse registering apparatus, one of which was operated by currents due to the closing of the circuit by the rotation of the test apparatus, while the other was operated by a clockwork giving equal intervals of time. The arrangement of this apparatus is shown in Figs. 2 and 3.

Several trials were made with flat surfaces fixed upon the two extremities of the horizontal arm, both for the regulation of the apparatus and in order to verify the exactness of trials made by other methods and the application of the formulæ already known. Further trials were made upon solid bodies of prismatic shape, the axes of these being vertical. These shapes were such that the irregular polygonal face of the solid could be inscribed within an ellipse whose axes bore the relation of two to one to each other. The conclusions of the experiments showed that the resistance of the air to a solid of this form could be considered as in the neighborhood of ninety kilogrammes per square metre at a velocity of fifty-five metres per second.

As may easily be understood, the determinations were made by measuring the energy absorbed by the driving motor and deducting that wasted in heat in the apparatus and absorbed by the resistance to the movement of the horizontal bar without the trial surfaces.

These data of maximum resistance being obtained, it was determined to round off the ends of the vehicle in a manner to diminish as much as possible the air resistance and to compensate the effect of the side walls of the cars. From various data the conclusion was reached that to overcome the resistance encountered by a twelve-wheel car weighing ninety-six tons at a speed of fifty-five metres per second, a power of about 1,000 horse-power was necessary.

THE DESIGN OF THE CAR.

It became necessary, then, to design a car furnished with an equipment having 1,000 horse-power. Of course the major difficulty lay in the relation between dimensions and weights of the various parts of this complex piece of apparatus, the conditions requiring the weights to be kept down while at the same time the parts should be made strong enough to withstand the large powers necessary for them to transmit.

Fig. 4 gives a general idea of the shape of the car.

The definite distribution of weights among the different parts is given in the table below:

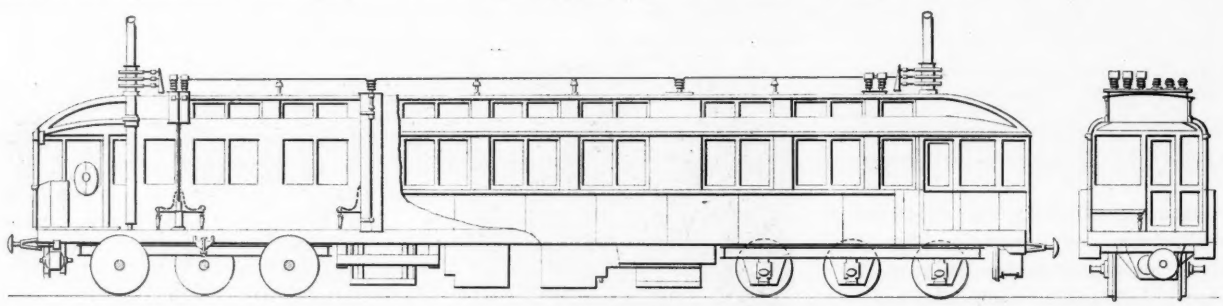


FIG. 4.—OUTLINE GIVING A GENERAL IDEA OF THE SHAPE OF THE CAR, BERLIN-ZOSSEN EXPERIMENT.

(a) MECHANICAL PART.	t	Lbs
Body of the car and beams, woodwork, windows, air and hand-brakes, with rods and connections, pipes and reservoirs, flooring and roof, complete..	20,700	45,540
Running gear complete, comprising wheels, brake-rods, reserve reservoirs for compressed air and brake cylinders.....	27,300	60,060
Total	48,000	105,600

(b) ELECTRICAL PART.

	Kg.	Lbs
Motors, without hollow axles or wheels, including suspensions	16,300	35,860
Rheostats and starting apparatus	5,100	11,200
Controller, comprising the apparatus for working the air-brake, piping, safety cutouts, fuses and all the control apparatus in the motorman's cab	4,750	10,450
Large transformers, with their suspensions	12,300	27,060
Air pumps and mountings.	1,000	2,200
Small transformers for the air pumps	650	1,430
Hand-wheels, levers, rods, rings and other regulating apparatus	1,300	2,860
Electric lighting apparatus, including battery	500	1,100
Total	41,900	92,160
To which add for safety	600	1,320
Grand total	42,500	93,480

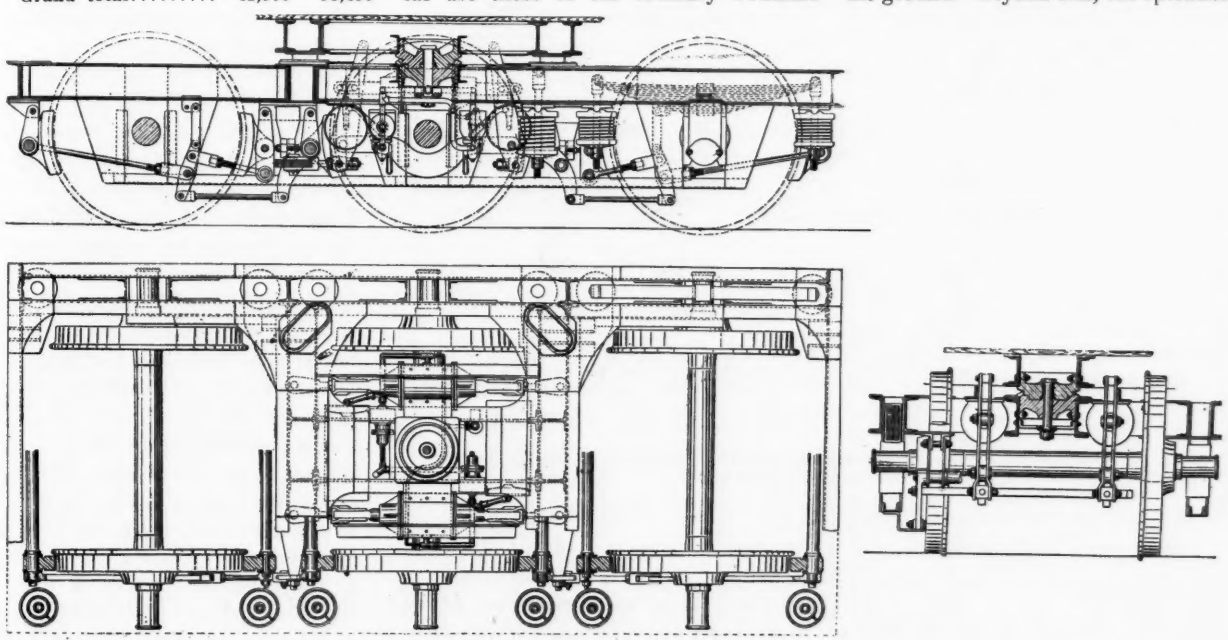


FIG. 5. SKETCH PLANS AND ELEVATIONS OF TRUCKS FOR THE BERLIN-ZOSSEN CAR.

(c) PASSENGERS.

	Kg.	Lbs
Fifty persons, the conductor and motorman included	4,000	8,800
Total of all weights.	94,500	207,880

MECHANICAL EQUIPMENT.

The house charged with the construction of the car was given the following specifications:

MECHANICAL DESIGN.

The specifications under which the cars were constructed contained the following provisions:

The car should be sufficient to carry fifty passengers on transverse seats in a central apartment and two end apartments. The central room has eighteen seating places, and each of the other compartments contains twelve seats. The entering vestibules give room for three seats, and at each end of the car is placed a cab for the motorman. The total capacity of the car is thus for forty-eight seated passengers and the length of the car over all is twenty-two metres (sixty-seven feet).

The car body is mounted on longitudinal sills provided with cross-trussing at two levels, ensuring a very strong and rigid framework with relatively small weight. The cross-trusses are built of U-bars and flat plates and are tied with strong tie-rods running from the lower sills of the windows to the lower chord of the longitudinal sills. The latter are furnished with transversal and longitudinal reenforcing webs, while both ends of the cars carry the standard couplers and buffers used on the Prussian Government railways. The internal arrangements of the car are those of the ordinary Prussian third-class railway car. The seats are simple wooden benches mounted on iron supports. The exterior appearance of the car body is similar to that of ordinary passenger cars on main-line trains. On account of its peculiar construction the body of the car rests directly upon the king-pins of the trucks without the necessity for any particular system of springs. Upon the trucks themselves the middle axles are not equipped with motors, the space being fully occupied by the seat of the king-pin and brake apparatus.

The principal brakes are of the Westinghouse automatic pattern (Fig. 5) and work upon all the wheels on both sides of the car with a total pressure equal to 160 per cent of the weight of the vehicle. Upon each of the trucks are carried two brake-cylinders, each ten inches in diameter. In addition to this air-brake system is also an ordinary mechanical brake by means of which from either motorman's cab the two trucks may be braked with an effort equal to eighty per cent of the weight of the car. The wheels have a thread diameter of forty-nine inches.

THE ELECTRICAL EQUIPMENT.

In the electrical equipment of this car the greatest care was taken to secure the complete safety of passengers and of the men in charge from any danger from the high-tension currents employed. This safety is obtained by making all of the high-tension apparatus and all of the conducting systems external to the body of the car, either above the roof or below the floor, and in putting both roof and floor in permanent electrical connection with the ground. Beyond this, the operation of the various control mechanisms is not made directly by the hands of the motorman but indirectly through the aid of a secondary source of power. For this purpose compressed air is used, taken from the same reservoir which serves the brakes. Naturally at the same time care was taken in the design to arrange the electrical apparatus so as to make its supervision easy and its assembling and dismounting as little difficult as possible in case of breakage or derangement. Care was also taken to avoid the disabling of any part of the electrical equipment through the failure of another part. These considerations lead to the division of the electrical equipment into two similar units, each of which comprises:

(*a*) Two motors with two groups of resistances, two controllers, two switches and two circuit-breakers.

(*b*) A large transformer, with accessory apparatus needed for connecting its terminals in star or delta, with the necessary primary circuit-breakers and other high-tension switches.

(*c*) An air-pump with a small transformer, a circuit-breaker and a regulator.

(*d*) A complete current-taking system or trolley.

(*e*) One motorman's cab with appliances for handling the compressed air and measuring apparatus.

circuit, at the commencement of motion in the motor, has a tension of about 650 volts. In order to handle this with the utmost safety and certainty it was determined to use metallic resistances, placed in flat boxes along the two sides of the car between the entrance doors. In order to shorten the leading wires to these resistances and also to facilitate access to the control system the controller cylinders were also subdivided in the same way as the resistances. The axles upon which these cylinders turned are worked by a simple mechanical transmission from the motormen's cabs.

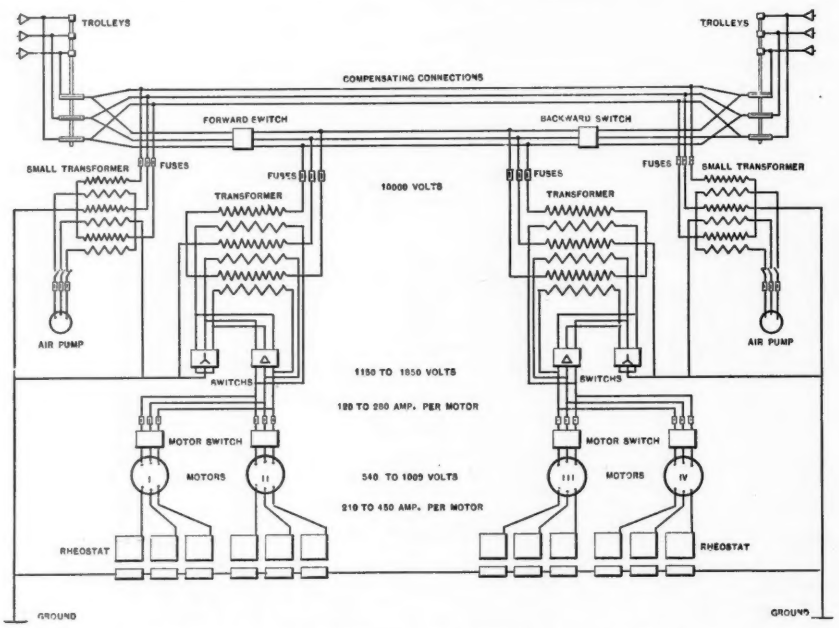


FIG. 6.—THE ENTIRE SYSTEM OF CONNECTION BETWEEN ALL THE ELEMENTS OF THE ELECTRICAL EQUIPMENT.

In Fig. 6 is shown very clearly the entire system of connections between all of the elements of the electrical equipment from motors to trolleys.

While the diameter of the wheels was made unusually large, being about forty-nine inches, nevertheless the rotation speed of these is so high that it is possible to couple the motors directly with the axles. Each truck is furnished with two motors, making a total of four upon the car, each of which can develop 250 horse-power. The various considerations governing the choice of a secondary voltage led to the selection of 1,150 volts as the primary tension on the motors while running, and 1,850 volts during the period of acceleration.

The government of the motors during starting is accomplished by means of resistances cut into the secondary circuit, which can be removed one after the other until the secondary of the motor is finally completely short-circuited. The secondary

As stated above, the motors take primary current at 1,150 or 1,850 volts through a system of medium-tension apparatus. These two pressures are obtained respectively by connecting the transformer in delta or in star, a switch for this purpose being put into the secondary circuit of each transformer. For each of the four switch apparatus is provided a cutout arrangement, so disposed as to make it easy to remove for repair and re-fusing. The control apparatus is operated by means of compressed air for which a special pipe system is laid from the motormen's cabs. In these cabs are also the circuit-breakers for the motors.

(To be continued.)

Mica.

The *British Trade Review* states that last year mica, in common with many other articles, suffered from the prevailing general depression in trade.

In Germany the commercial crisis has accentuated the depression in the electrical trades. As that country is one of the largest customers for Indian mica, this has slackened demand generally, especially as regards the larger-sized slabs. While the European demand all round has been quiet, stocks of good useful sizes and qualities have been in short supply, and, should enquiries continue to run on medium grades and the larger remain neglected, it is not unlikely that values for the smaller sizes will go to a premium. Nature has, unfortunately, not arranged the mica crystals in convenient lots of graded sizes. Thus, taking Bengal mica at the present time, there is no incentive to either the European or the native mine-owners to work their deposits to their full capacity. The grades at present mostly sought after are, perhaps, Nos. 3, 4, and 5, the latter either in the form of slabs or splittings. To provide these grades means also the mining of the larger crystals and the accumulation of stocks of the very sizes for the sale of which the mines mainly depend for their profits. These remarks apply specially to Bengal, but also to Madras in a lesser degree. Imports into the United Kingdom for 1901, as compared with 1900, show a decrease both from Calcutta and Madras. Owing to mica not being classified by itself in the official returns, only approximate quantities can be arrived at, but Messrs. Tulloch & Company estimate the imports from Calcutta at about 6,200 cases, and about 6,100 cases from Madras. Direct importations to Continental ports amount to about 400 cases. During 1901 South American mica was also in evidence to a larger extent, but no detailed returns are obtainable. Canada has also exported a rather larger quantity to the United Kingdom and Continent, but this description does not attract much support at present from the electrical trades. Stocks in London in importers' hands of good quality and useful sizes are light, smaller, indeed, than for some time past. The firm estimate that at the present time stocks of Calcutta clear ruby and ruby stained do not amount to over 600 cases. In this estimate they exclude Nos. 5 and 6 grades, also films. As regards Madras, roughly, they estimate stocks of good quality and salable sizes to amount to not over 1,400 cases. In this case also they eliminate the heavy stocks of Madras smalls and splittings which are still in warehouse, but do not come under the category of good merchantable sizes or quality. The firm add that the apathy shown by buyers in face of the above good statistical position is proof of the current very small consumption by the trade.

The Protection of Lines and Apparatus from Electrostatic Strains.

A Lecture by Mr. Percy H. Thomas Before the American Institute of Electrical Engineers.

(Concluded.)

STATIC INTERRUPTER.

To meet this very serious difficulty the author proposes the use of a device he has called the "static interrupter." "The static interrupter" is a combination of a choke coil and a condenser connected in such a way as to magnify the effect of the choke coil as regards static waves without a sensible derangement of the normal operation of the circuit. By the use of this device a comparatively small coil can be made to afford the same protection as a coil of much larger dimensions without entailing either excessive cost or excessive loss of energy or heating.

The static interrupter consists of a choke coil in series with the line and a condenser connected by one terminal between the choke coil and the winding to be protected and by the other terminal to such parts of the apparatus as have e. s. capacity with this high-tension winding, in a transformer to the low-tension winding and the core. However, as these parts are always (as compared with the high-tension) at ground potential, the second condenser terminal may be connected directly to ground. The diagram of connections for the interrupter protecting a transformer or generator is shown in Fig. 7.

PROTECTIVE POWER OF STATIC INTERRUPTER.

It is evident that more time is required for sufficient charge to pass the choke coil to charge the transformer terminal and condenser together than would be required to charge the terminal alone. This means that the maximum static strain will be distributed over a larger number of layers in the first case than in the second. The ratio of the e. s. capacity of the condenser to that of the transformer terminal and the adjacent parts of winding is an important factor in determining the protective power of the interrupter, as it indicates the extent to which the potential of the terminal is reduced by the addition of the condenser. It is possible to get almost any desired degree of protection by the use of a sufficiently large condenser without unduly increasing the size of the choke coil in series with the circuit. Actual experiment shows this method of protection to be very effective in reducing the static strains in coils.

On the other hand the use of the static interrupter, although it delays the penetration of the crest of the advancing static wave, does not necessarily prevent the ultimate rise of potential of the terminal; that is, it affords no direct protection against grounds. However, in cases where the interrupter is used in connection with a lightning arrester (which should always be connected on the side of the choke coil farthest from the condenser) the delay of the wave does give additional protection against grounding of the winding as it allows the arrester more time to discharge the line.

The interrupter performs a more important function in connection with the discharge of an arrester by protecting the

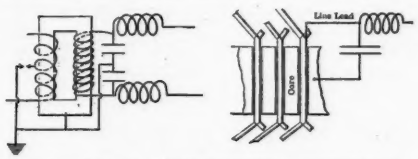


FIG. 7.—STATIC INTERRUPTER PROTECTING A TRANSFORMER AND HIGH-TENSION GENERATOR.

winding from the violent strains that result from the abrupt grounding of the circuit caused by the discharge. As the discharge of the arrester occurs only when line potential is much above normal and may be carried momentarily much beyond ground potential on account of its oscillatory nature, the shock to the coil may be a very severe one.

LOCATION IN CIRCUIT OF STATIC INTERRUPTERS.

It is thus evident that by placing a proper static interrupter in each lead wire of a transformer or other apparatus which may be connected with a source of static disturbance such as a line or a high-tension switch, complete protection may be secured against short-circuits in the windings caused by static originating outside of the transformer. As switching is a frequent cause of static strains, the interrupters should in general be placed between the apparatus and the switches, thus making the interrupter virtually a part of the transformer or generator to be protected and not a part of the line. If, however, each individual transformer is provided with static interrupters a larger number of interrupters is required than would be necessary for protecting a bank of transformers as a whole from disturbances upon the transmission line. If there is no switching of individual transformers it is then satisfactory to arrange the apparatus so that several transformers will be protected by the same interrupters. For example, in polyphase systems a group may be protected as a unit instead of giving individual protection to each transformer. The precise arrangement of apparatus in a given case will depend upon the number of transformers to be protected and the arrangements which are provided for switching.

There are certain cases in which switching may be done between the interrupter and the transformer. The transformer may be cut out of circuit by the opening of circuit-breakers, fuses or switches, or transformers may be connected to a live high-tension circuit, provided their low-tension windings are at the time supplied with current from the same generator as the circuits from which they are switched. Such switching causes no change of potential at the terminals and consequently no strain.

Also fuses and circuit-breakers may be opened by overloads or short-circuits without regard to the low-tension connections or without danger from static as the arc formed assures a gradual change of potential.

The proper connections for static interrupters in the arrangements of apparatus most frequently found are shown diagrammatically in Fig. 8.

FEATURES OF COMMERCIAL STATIC INTERRUPTERS.

Some of the features of actual static interrupters intended for commercial service work may be of interest. These interrupters are usually single pole; that is, one coil and one condenser are placed in a containing-case. As the interrupters are used on high voltages, coils and condensers are placed in oil. The oil facilitates the cooling as well as strengthening the insulation. The choke coils, which contain no iron, receive the full force of the static waves which they are intended to check, and are very heavily insulated. On a

three-phase circuit the condensers must support continuously a strain approximately six-tenths of the normal line voltage without breakdown and without overheating; they must also be able for moderate lengths of time to stand full-line voltage in case one leg of the circuit becomes grounded.

The fact may not be generally appreciated that condensers have a very considerable heat loss which must be carefully considered in designing the interrupter. This loss for any given dielectric varies in actual condensers approximately as the square of the voltage, and increases rapidly with the temperature. The loss in a condenser may be increased several times by changing its temperature from 20 degrees centigrade to 100 degrees centigrade. This fact indicates the importance of not allowing condensers to get hot.

The actual e. s. capacity of condensers for static interrupters is made much larger than the e. s. capacity of the windings they are to protect, but is still very small—seldom exceeding a few hundredths of a microfarad. The reaction of the condenser upon the circuit for generator frequencies is therefore negligible.

PROTECTION AGAINST GROUNDS.

A ground is the result of a rise of potential higher than the insulation of the apparatus is adapted to withstand (assuming that the insulating material contains no local defects). Such an excessive strain may result from static disturbances or from other causes. It has been shown that lightning may be one cause, and that under circumstances switching and similar disturbances may produce high momentary voltages. Therefore, unless the apparatus is insulated to stand such excessive potentials, which may be possible with low and moderately high-voltage circuits, but is hardly practical with extra high-tension, we must use some means of prevention. The standard lightning arrester spark-gap used to prevent excessive potentials from lightning is effective also against other causes of static.

LIGHTNING ARRESTERS.

A simple air-gap between line and ground is an ideal lightning arrester or line discharger as far as its protecting power is concerned. It absolutely resists the passage of current up to a certain voltage which can be predetermined quite closely, and if this critical voltage is exceeded, breaks down and furnishes a non-inductive and nearly resistanceless discharge path for carrying off any amount of static electricity that may appear on the line. This means that when once the gap has broken down no amount of charge on the line can raise its potential above the ground. However, if the ground connection be not perfect or if either in the arrester or in its connections there is sufficient inductance or resistance, it is then possible to have a dangerous rise of potential on the line after the air-gap has broken down due, of course, to the checking of the discharge of the line by the inductance or resistance.

Unfortunately, however, when single spark-gaps are used as lightning arresters, then simultaneous discharge on two or more legs of a line forms a short-circuit on the line, and the usual result follows. If one leg of a circuit is accidentally or permanently grounded an arrester discharge on any one of the other legs causes a short-circuit.

The air-gap lightning arrester to be commercially successful, in addition to giving protection from static, must be able

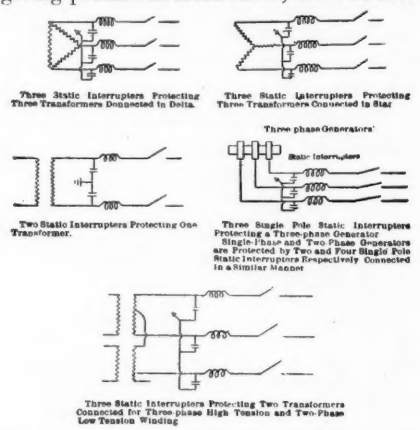

Three Static Interrupters Protecting Three Transformers Connected in Delta.
Three Static Interrupters Protecting Three Transformers Connected in Star
Three phase Generators'
Two Static Interrupters Protecting One Transformer.
Three Single Pole Static Interrupters Protecting a Three-phase Generator
Single-Phase and Two Phase Generators are Protected by Two and Four Single Pole Static Interrupters Respectively Connected in a Similar Manner
Three Static Interrupters Protecting Two Transformers Connected for Three-phase High Tension and Two-Phase Low Tension Winding

FIG. 8.—DIAGRAM SHOWING ARRANGEMENTS OF STATIC INTERRUPTERS, PROTECTING GENERATORS AND GROUPS OF TRANSFORMERS.

to interrupt the short-circuit current which tends to follow lightning discharges. The devising of an arrester to meet all conditions is a very difficult problem. Fortunately, however, a large number of small gaps in series may be substituted for one single gap of larger dimensions which greatly increases the "non-arcing" power. A very few gaps of non-arcing metal are satisfactory under some conditions, but the more the gaps are subdivided the more effective the arrester. On high voltages, however, and under some other circumstances, such a large number of these gaps must be used on the arrester, as to interfere with its protective power by requiring a rather excessive voltage to cause the gaps to discharge. If the amount of the current that can flow on short-circuit be limited either by series resistance or otherwise, a considerably reduced number of gaps will be non-arcing.

SERIES RESISTANCE.

The use of series resistance to render an arrester non-arcing has the advantage of cheapness and simplicity, and is very effective as far as rendering the arrester non-arcing is concerned, but it has the great disadvantage of introducing the resistance in the path of the discharge of the line. In many plants the small size of the generators limits the current flow on short-circuit in such a way as to render no series resistance necessary. It must be remembered in this connection that all synchronous apparatus connected to an electric circuit (and sometimes induction motors) will temporarily act as generators at the time of a lightning discharge on account of the energy stored in the momentum of their revolving parts.

In many cases where the short-circuit current taken by the arrester is not excessively large the series resistance may be shunted by additional gaps which will allow the static discharge to pass directly to earth around the resistance. If the parts are properly proportioned, the subsequent arcs will be drawn from the shunted gaps by the resistance and thus extinguished. If the number of shunted gaps is no greater than of the unshunted gaps no greater voltage will be required to discharge over the whole number than over the unshunted gaps alone. This is because the shunted and unshunted gaps are separately broken down—one after the other. Therefore, no protecting power is lost by the addition of the shunted resistance.

In the cases where such resistance, shunted by gaps, is not sufficient a small series resistance in addition will make the arrester non-arcing. In other words, where a large series resistance is required part of it may be shunted by gaps in such a way as to introduce only a small resistance in the discharge circuit of the arrester.

It should be noted, as in the case of short-circuits in coils from static sparks, that if the discharge through an arrester passes at or near the time of zero electromotive force of the generator, there will be little likelihood of a permanent short-circuit.

Although the insertion of resistance in the discharge path of an arrester may, under some circumstances, prevent the very thing that the arrester is supposed to accomplish, nevertheless its great effectiveness in rendering the arrester non-arcing and its wide commercial use require a statement of the conditions under which it may safely be used. It evidently makes no difference how much resistance or inductance is used in series with an arrester provided it is always able to discharge the electricity as fast as it actually appears on the line at the point where the

arrester is connected, without causing a potential in the arrester greater than that required to cause the arrester to discharge in the first place. In discharging electricity a resistance requires a potential equal to the product of the current strength and the resistance; inductance causes a counter electro-motive force equal to the product of its inductance and the rate of increase of the current. At each instant of time the current flowing in the arrester circuit has a definite value and a definite rate of increase (or decrease). Therefore, for the arrester to meet the above condition the sum of the two potentials caused first by the current at the moment flowing in the resistance and second by the rate of increase of current in the inductance, must at no time exceed the potential required to cause the arrester to discharge.

It will be readily seen that the greater the quantity of static electricity to be discharged and the more sudden its appearance, the more severe the conditions on the arrester. Also that the greater the resistance and the inductance of the arrester circuit the greater the likelihood of a dangerous rise of potential. Just what the greatest allowable values of resistance and inductance are in any given case will depend upon various circumstances and can not usually be definitely predicted. Therefore, in all cases the lowest practicable amount of resistance and inductance should be used in series with the discharge path of the arrester. It should be noted that with an increasing current flow through the arrester circuit the quantity of electricity discharged by the arrester before the dangerous point of potential is reached will be much more than proportionally greater with a low than with a high resistance. That is, if the series resistance in one case is one-half that in another, both discharging the same increasing current, the quantity of electricity that will have passed the first arrester when a given potential is reached is much more than twice that passed in the second case when the same potential is reached. This fact makes it still more desirable that series resistances should be kept as low as possible.

Resistance and inductance in series with the arrester circuit have the advantage of preventing to some extent the very sudden grounding of the line that otherwise results from the arrester discharge and which causes severe strains in the windings of adjacent apparatus. This is an advantage by no means to be overlooked, for it will be remembered that short-circuits are much more frequent than grounds.

LOCATION OF ARRESTERS.

A proper air-gap lightning arrester will prevent an excessive rise of potential above the ground at that point of the line to which it is connected, but on account of the wave nature of the static disturbances it will not necessarily prevent an excessive rise of potential at some other point of the circuit more or less distant. For if the arrester happens to be at the zero point of a wave the arrester will not discharge, even though the crest of the wave at some other point may be at a very high potential above the earth.

It is a somewhat difficult problem to obtain complete protection at all points; however, in actual circuits adequate protection can usually be secured. Actual commercial plants fall into two classes, *viz.*, plants in which the apparatus connected to the high-tension circuits is scattered about at numerous more or less widely separated points and plants where the apparatus is all concentrated at a few points.

(*a*) PLANTS WITH APPARATUS DISTRIBUTED.

For absolutely complete protection from ground in plants having distributed apparatus arresters will have to be placed wherever there is apparatus that needs protection. In most cases this would mean an almost prohibitive expense. Fortunately such plants are ordinarily of comparatively low voltage, and therefore require protection (as far as static from grounds is concerned) only from lightning. Therefore, by placing arresters in such locations as to readily discharge static waves that may arise in the most exposed portions and by scattering arresters at intervals over the line at other points sufficient protection is secured. The exact number of arresters required in any given case depends upon the local conditions. This type of circuit, with distributed apparatus, is seldom found above 3,000 volts.

(*b*) PLANTS WITH APPARATUS CONCENTRATED AT A FEW POINTS.

In these cases the sources of static disturbance are either at some point away from the apparatus or are, electrically speaking, at the point where the line enters the station; that is, where a rise of potential is caused by switching in the station, all the high-tension wiring is at the same potential and the rise can be limited by an arrester placed on each leg of the line at the point where the line enters. But these arresters, provided they be placed on the line side of apparatus, will also protect from dangerous static waves produced at points away on the line, for such waves must pass the arrester before they can reach the apparatus, and will thus cause the arrester to discharge. Therefore, in circuits of this type, which includes practically all high-tension circuits, protection from grounds will be secured by proper arresters, placed one on each line wire where it leaves a station. The arrester must be placed outside of all choke coils and static interrupters, so that these may prevent static strain in the apparatus from the discharge of the arrester. This distribution of arresters is the one that has usually been followed in actual installations.

The system of protection that I have outlined for the protection of high-tension circuits, therefore, consists of the use of proper lightning arresters at appropriate points to protect against grounds, and static interrupters to protect apparatus against short-circuits. The lightning arresters should be of adequate design, but no radical change from the usual present practice in regard to location is required.

The use of the static interrupter is, however, new, and it has been one of the objects of this paper to give a full exposition of the protection it affords and to discuss fully the conditions which render its use advantageous.

SUMMARY.

A summary of the most important conclusions regarding arresters and interrupters follows:

(1) Damage resulting from static strains is of two sorts—short-circuits and grounds. It is the function of the static interrupter to protect apparatus against such short-circuit strains; it is the function of the lightning arrester to discharge the line of excessive static charge and thus prevent grounds.

(2) The static interrupter consists of a choke coil and condenser, the latter being connected between line and ground on the apparatus side of the choke coil. The interrupter delays and smoothes out static waves which attempt to pass it. The condenser by absorbing a large part of the static charge which passes the choke coil very much increases the effectiveness of the coil.

(3) The choke coil and condenser of the interrupter must be adapted to the circuit upon which it is to be run, and must be proportioned with regard to the design of the apparatus it is to protect. The interrupter should be placed nearer the apparatus than any switches which are to be operated with potential on the line. (See page 323 for exceptions). The interrupter is thus essentially a part of the apparatus to be protected and not a part of the line or the arrester.

(4) Lightning arresters must be able to discharge electricity from the line as fast as it actually appears there, and must also be non-arcing under all conditions. Any resistance or inductance used in series with the arrester should be low enough to allow the passage of all actual discharges without causing excessive potential on the arrester.

(5) On the systems where the apparatus is distributed the arresters should also be distributed.

On systems with apparatus concentrated at a few points arresters should be placed on each line wire where it leaves a station.

(6) Well-designed static interrupters and lightning arresters, properly arranged, furnish a complete system of protection against the static disturbances found on high-tension lines.

It is quite evident that the protection of the apparatus of a large high-tension system, with its numerous opportunities for static disturbances and its widely-spread apparatus, is by no means a simple problem, to be solved off-hand by the use of a few lightning arresters of any available style. The type and location of the protective devices must be adapted to the actual conditions of the plant; the severity of the lightning in the neighborhood, the voltage of the system, the type of apparatus to be protected, and perhaps the actual constants of the circuits. The determination of the most satisfactory protection is a matter to be arrived at from a combination of theory, experience and experiment, and any protective system should be freely modified when actual trial shows a better arrangement. It is to be hoped that engineers and others who have the opportunity will carefully study the questions of static experimentally, giving them all the attention that their importance deserves, and that we may in consequence look forward to the time when difficulties from static causes may be practically unknown.

Compliment and Comment.

A Few of the Opinions on the "Electrical Review's" Anniversary Number.

Read All the Pages.

[*New York Times.*]

The ELECTRICAL REVIEW of this city, which claims to be and, so far as we know, is the pioneer electrical weekly of America, has completed another year of its bright and prosperous career, and issues an enlarged number, under date of February 15, in commemoration of its twentieth anniversary. Avowedly it is devoted mainly to showing the contrasts between to-day and twenty years ago in the development of the electrical arts and trades, and engravings showing some of the earliest applications of the art, and portraits of men prominent in various ways in its field add greatly to its value. It may be mentioned as a matter not without interest that, while the "reading" part of this number is comprised within a little less than seventy pages, there are a full hundred pages of advertisements. Who shall say that the latter will have the fewer readers? Or that less benefit will be derived from them?

Completeness.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I wish to compliment you on the completeness of the Anniversary Number of the ELECTRICAL REVIEW. C. W. RICE.

55 Duane street, New York, Feb. 27.

Will Continue to Read the "Electrical Review."

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I have always found your publication newsy, accurate and interesting. I enclose my check for this year's subscription, for I have formed "the ELECTRICAL REVIEW habit" and have no wish to swear off. ALBERT M. BULLARD.

Tufts College, Mass., February 28.

"Felicitations Due."

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I think your issue so excellent that felicitations are due—and I tender them truly most cordially.

THOMAS D. LOCKWOOD.

Boston, February 20.

"Full of Good Things."

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I have before me a copy of your Twentieth Anniversary Number, which is full of good things and also reminiscences of past years, and I desire to extend to you many congratulations on the development of your publication, and wish it and yourself continued success in the coming years.

Phila., Feb. 19. GEO. H. LEWARS,
Business Manager, Curtis Publishing Co.

"Deserving of Great Praise."

TO THE EDITOR OF THE ELECTRICAL REVIEW:

Your Twentieth Anniversary Number is certainly a very excellent one and deserving great praise for the enterprise shown both in its editorial and advertising pages. Please accept my congratulations on the success of your efforts.

New York, Feb. 18. H. M. DAVIS,
Manager Advertising, Sprague Electric Co.

"Doing Good Work."

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I can not refrain from adding to the many you are bound to receive my hearty congratulations on the twentieth anniversary of the ELECTRICAL REVIEW, nor from expressing my admiration of the magnificent number by which the event is most fittingly celebrated.

Although no longer connected with the electrical industry, I am nevertheless deeply interested in what pertains to it and am a silent admirer of the tremendous strides it is making and it is because of this, together with my recollections of the years I was associated with it and of the many friendships then formed, that I welcome each number of the ELECTRICAL REVIEW.

Surely it has done and is doing good work and to see its increasing usefulness and influence must be a source of deep gratification to you. As an instance of this influence and usefulness I may mention Louis Bell's article on the problem of rapid transit in this city—it seemed to me so good and so directly to the point that I have referred it to many of my friends by whom, without exception, its conclusions were endorsed. I believe that it will have a good effect on the future of the vexed problem in this city.

HENRY B. CRAM.

Boston, February 20.

"Rapid but Good."

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I am pleased to see that your growth has been not only rapid but good.

G. A. REDMAN.

Rochester, N. Y., February 27.

"Great Piece of Work."

TO THE EDITOR OF THE ELECTRICAL REVIEW:

The Twentieth Anniversary Number of the ELECTRICAL REVIEW is a great piece of work. The photograph of the founder is especially good and the liberality of the advertiser on page 117 is marked.

New York, Feb. 18. H. D. LYMAN,
President, American Surety Co.

"The Best Number."

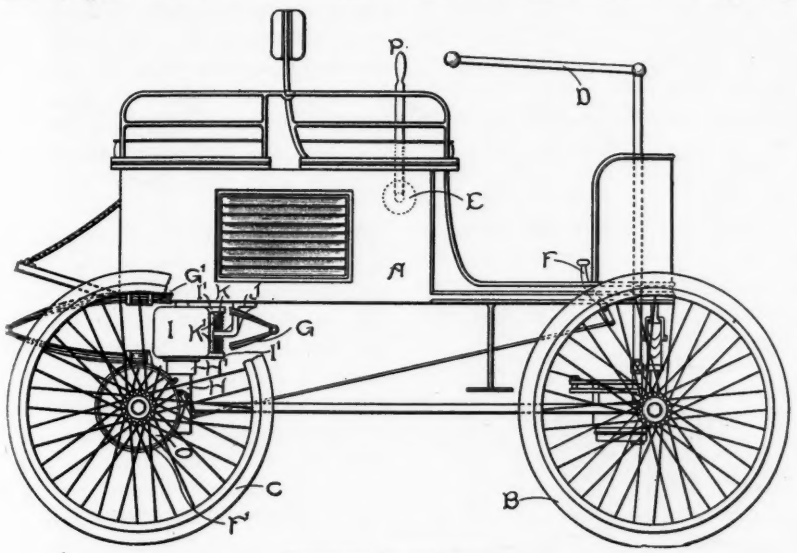
TO THE EDITOR OF THE ELECTRICAL REVIEW:

I think your Anniversary Number is the best issue the ELECTRICAL REVIEW ever published. A. M. YOUNG.

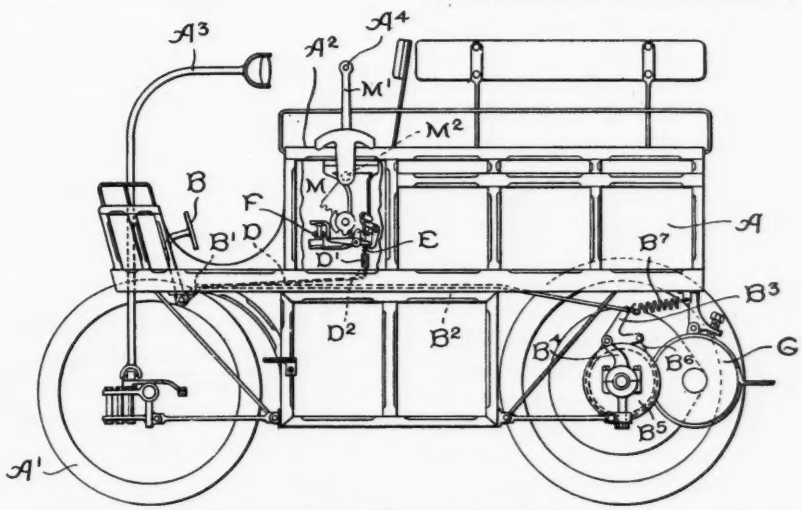
New York, February 20.

Electrical Patents

Mr. Hermann Lemp, of Lynn, Mass., has just been granted thirteen patents on improvements in automobiles, all of which he has assigned either to the General Electric Company or Professor Elihu Thomson. We have selected a few of the most important and broadly new ideas from these various patents, and present illustrations of the same. The first relates to the general structure and operation of electrically propelled vehicles. In the operation of the same it is desirable to employ a high-speed motor or motors and to gear said motor or motors to the driving-wheel or wheels by a mechanism which will make little or no noise. It is preferable to use a motor in which the reduction of speed between the armature and the driving-wheel is about twenty to one. If such motor is employed, considerable weight may be saved or a greater efficiency may be secured for the same weight. The only satisfactory means of transmission for such high reductions is worm-gearing. With worm-gearing, when the ratio of transmission is greater than eight to one, the angle of the worm is such that it can not be driven backward. In other words, the vehicle can be driven by the motor-armature; but the worm can not drive the armature when the power is cut off and the vehicle permitted to coast. With a greater ratio of gearing than one to eight, if power were suddenly cut off, due to accident or otherwise, it would either destroy the working mechanism or stop so suddenly as to throw the occupants out of the vehicle. The inventor overcomes the objection pointed out by utilizing an electrically actuated clutch, which clutch is provided with an energizing coil that is in series with the propelled motor or motors. The clutch is preferably designed to lock the motor armature to the driving mechanism as distinguished from those clutches in which a certain amount of slip is permitted and desired. If, however, it is desired to get an intermediate regulation differing from that afforded by the controller or for any other reason, the clutch can be arranged to slip. With an arrangement of either kind, when the current is cut off from the motor or motors, the gearing between the motor and the driving-wheel or wheels is disengaged and the vehicle is free to coast. A satisfactory arrangement is to suspend the motor from the vehicle body in a vertical position, with the worm on the armature shaft acting on the front side of a worm-wheel carried by or secured to the driving-wheel or wheels. Preferably the clutch for controlling the mechanism is of a type in which the exciting coil is stationary and mounted on a stationary axle, while the magnetic keeper or armature is a part of the driving wheel. Of course, a moving coil may be used whenever any advantage would follow therefrom. Another invention has relation to the controller for electric vehicles, the object being to place the same more completely under the control of the person in charge. This is accomplished by providing mechanism which makes it impossible to apply the brakes, whether they are mechanical or electric, without first throwing off the power. As it is not economical in storage battery systems to start an electric carriage at a high acceleration, the circuit combination in the present device is such that the speed of the vehicle can be increased in a smooth and gradual manner. This is accomplished by advancing the controller in a step-by-step manner, the time intervals between steps being sufficient for the vehicle to attain the speed intended for each particular step before going to the next. As is well known, it is very injurious to reverse the motor or motors while the vehicle is still moving, since current from the battery flowing through the motor or motors under these conditions is very heavy, there being no intermediate resistance. When the battery discharges under the above conditions, the current will sometimes rise to several hundred amperes, and the consequence of suddenly reversing the vehicle and supplying such a heavy current to the motor will result in a wreck or the breaking of the propelling gears. The inventor overcomes this in substantially the following manner: He provides the usual brake and foot-operated mechanism connected thereto, but to this foot lever is also made

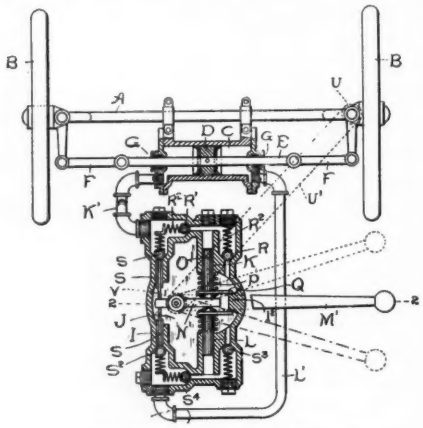


ELECTRIC AUTOMOBILE.

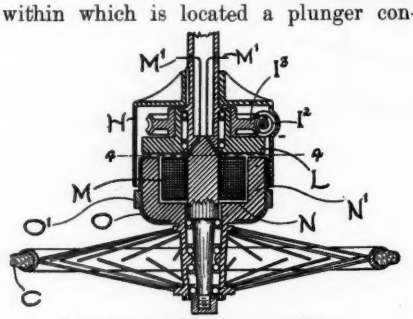


CONTROLLER FOR ELECTRIC AUTOMOBILES.

another connection which is yieldingly attached to the controller, so that when the brake is operated, at the same time, the controller will be moved to cut off the current. The yielding connection, however, is of the greatest importance, as it permits the operation of the controller independently of the brake, so that in coasting the current may be cut off from the motor without applying the brake. A third novel idea devised by the same inventor relates to the steering mechanism, which is especially intended for use on heavy trucks and the like. In these large, cumbersome vehicles, it has been the custom to employ gears of one sort or another, the object being to increase the leverage between the steering handle and the wheels, while the gear acts as a lock to prevent the accidental movement of the wheels and eliminate any strain on the hand of the operator. This inventor proposes to do away with gears and employ hydraulic mechanism, in the form of a suitably arranged motor connected to the wheels, and a pump of which the steering handle forms a part. By this arrangement, when the operator moves the handle in one direction or the other, the pump will be operated, thereby forcing the liquid to the motor, which in turn actuates the wheels one way or the other. His preferred form of construction is clearly illustrated in the accompanying cut. The wheels, as usual, are pivoted upon the ends of the axle and are connected through the medium of links and a piston rod that passes through an intermediately disposed motor, a centrally arranged piston being secured to the piston rod and in the motor casing. Pipes lead from the motor to a peculiarly constructed double-acting pump having separate pistons and independent sets of valves, all of which are arranged to be operated by the single steering handle. The arrangement is such that when the steering handle is moved to one side of its central position, fluid is forced from the pump to one side of the motor, thereby operating the piston and turning the wheels in one direction. In like manner, when the handle is operated upon the other side of its normally central position, the fluid is forced into the opposite side of the motor and the movement of the wheels is reversed. Still another invention relates to means for locking the wheels against movement, when said wheels are operated directly through the medium of the handle lever and connecting links. In this case he provides a hydraulic locking device, one of the simplest forms of which is shown in the accompanying illustration. Pivotally secured to the front of the axle is a hydraulic cylinder, within which is located a plunger connected with the lever so as to be moved therewith. This plunger has a centrally arranged opening closed by a pair of valves located on opposite sides of said plunger. These valves are held closed by springs surrounding a valve stem that is also connected to the operating handle, the relation being such that when the handle is moved in one direction or the other one of the valves will be opened before the plunger itself can be moved, thus permitting the flow of liquid from one side of the plunger to the other. It will therefore be seen that as long as the handle is at rest the valve will be closed, and the liquid within the cylinder will therefore hold the plunger against movement, consequently locking the wheels from turning to the right or left. When it is desired, however, to turn the vehicle by operating the handle, one of the valves will be opened, so that when pressure is brought against the piston, the liquid may flow into the opening and force the opposite valve open against the pressure of the spring.

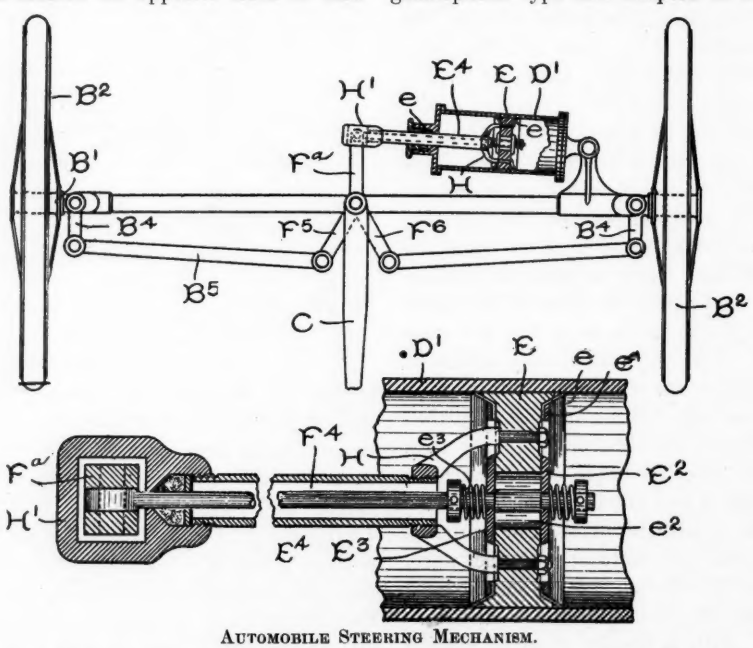


Automobile Steering Mechanism.



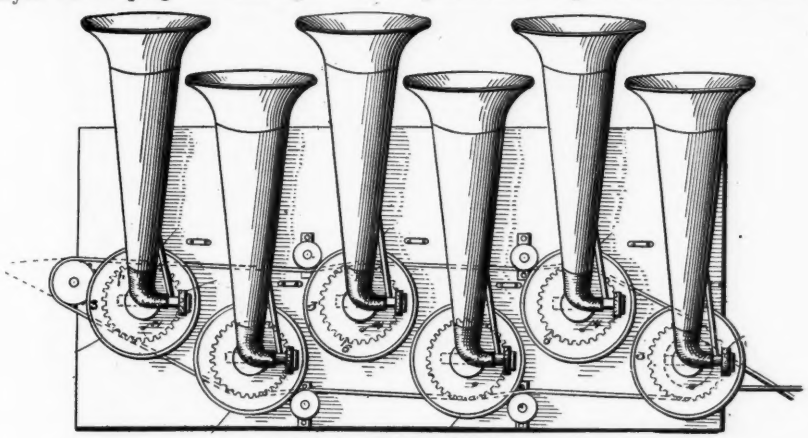
Automobile Wheel and Motor.

Mr. Emile Berliner, of Washington, D. C., who has been prominently identified with sound reproducing machines, has just patented important improvements in the same, his object being to reproduce sound in greatly increased volume. To this end he provides a machine made up of a number of separate gramophones, all of which may be operated simultaneously. As is well known, gramophone records are exact duplicates of each other even to the minutest detail, and as such are made in large numbers. The only difficulty to be overcome in operating several is to have them exactly register with each other and be operated simultaneously. He provides a table or support upon which are mounted a number of rotary tables of the usual gramophone type and adapted to receive the well-known record tablets of commerce. These tablets are generally arranged in a staggered row, each being supported on an upright spindle or shaft journaled in a standard fastened to the table. Upon each shaft just below the



Automobile Steering Mechanism.

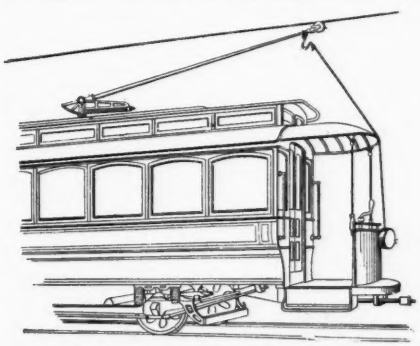
table is secured a disc having equally spaced radially projecting pins on its periphery. The discs are all of the same size with the same number of pins, and they are driven together with the tables at the same speed by means of a belt, having perforations spaced to fit the pins and operated by a motor of any desirable construction, suitable idlers being employed for keeping the belt tight. The



IMPROVED GRAMOPHONE.

amplifier horns are of the ordinary construction, as are also the reproducer heads which coact with the tablets. In order to ensure each record being placed in the same relative position on its table, the records are provided with orifices or seats, the seats and each identical record of a set being of the same relative position on the record. The tables have upwardly projecting pins which register with the orifices. This is only one way in which the several records may be brought into proper relation. In operation the records are placed on their tables or supports as described, and the reproducing styluses are brought down on the first lines. The registering devices, therefore, make it possible to ensure the contact of each stylus with a corresponding point of each record by the mere act of placing the stylus on the proper line. Power being applied to rotate the records identical sounds issue from each of the horns, and the combined body of sound may be made as great as desired by using an appropriate number of records. Therefore, it is possible to provide an exact reproduction of the human voice or to make it louder or softer. Another important point resides in the fact that a record may be made in the natural voice. Heretofore it has been customary to produce records by having the operator, whose voice is to be recorded, speak quite loudly into the apparatus, in order that the record might be made to reproduce as loudly as is possible. This has tended to distort the natural voice, but as already described the sound may be amplified as much as desired so that the unnatural methods heretofore employed will not be necessary.

In order to prevent the water collected from the conductor wire by the trolley of an electric car from passing down the controlling cord, Mr. Seth J. Buckland, of Springfield, Mass., has invented and patented a simple device which is in the form of a deflector interposed between the cord and the trolley pole. This deflector is in the form of a looped metal rod substantially S-shaped, one end of which is pivoted to the pole, the other end being secured to the controlling cord. The loop is disposed in a depending position so that the water collected by the trolley will run down and drip to the roof



WATERSHED OR DEFLECTOR FOR TROLLEY POLES AND ROPES.

of the car. The inventor employs several different constructions, one of which consists of a solid rod provided with eyes at its opposite ends, but the guard may be formed of a hollow tube through which the cord is passed, the tube being located on the rope at any desirable point between the pole and platform, the tension of the rope holding it against the longitudinal movement thereon.

An international exhibition of motor boats and of auxiliary motors for sailing boats is to be held at Berlin in June next, on Lake Wannsee. The general secretary is Mr. Oskar Conström, Berlin Univirsitäts-strasse, 1.

A New Record in Wireless Telegraphy.

Mr. William Marconi, inventor of wireless telegraphy, arrived in New York, Saturday, March 1, aboard the American Line steamship Philadelphia, upon which were conducted the most interesting and important experiments that have yet been made in the transmission of actual wireless messages to very great distances. The station at Pouldhu, in Cornwall, undertook to keep in communication with the Philadelphia as long as might be possible. Six messages were received during the first four days of the run, these beginning when the vessel was 250 miles distant from the sending station. On February 25, at 10.30 P. M., the last actual message was received at a distance of 1,551 statute miles, but at midnight of the next day, the distance then being 2,099 miles, intelligible signals, consisting as in the case of the first transatlantic experiment of the letter "S" repeated in several combinations, were distinctly obtained. All the messages were sent in one direction, the sending appliances on the steamer not being sufficiently powerful to attempt to return messages to the Cornish sending station.

It is rumored in London that the attitude of the British Government toward future long-distance wireless telegraph work will be to withdraw licences for it, as it is understood that it interferes in some degree with the apparatus employed aboard the vessels of the British Navy.

Manhattan Railway Generators Successfully Paralleled.

Last week the second of the great three-phase generating units for the Manhattan Elevated Railway Company was successfully started and connected in parallel with the first, which has been running for some time. It is interesting to note that this operation was immediately successful. Often considerable time is spent in adjusting engine governors, etc., before such large machines will run successfully in multiple with one another.

On the first test there was no exchange current between the machines, nor was there any necessity for adjustment of the engines. This is particularly interesting in view of the fact that the low-pressure cylinders of the engines were disconnected, and therefore the distribution of torque was not so good as it will be when all the cylinders are running together. The largest load that has yet been put upon these machines is about 2,000 kilowatts.

"Captains of Industry."

Among the many events in honor of Prince Henry of Prussia, who is visiting the United States, the luncheon given at Sherry's, in New York, by Mr. J. Pierpont Morgan, Mr. E. D. Adams, Mr. W. K. Vanderbilt, Hon. Abram S. Hewitt and a few others, has apparently received more attention than any other single occurrence of the occasion. It was understood that this gathering would consist of the leading individuals identified by deeds with the industrial progress of the United States.

There were 100 invitations extended and ninety-two attended. The distinguished visitor showed great interest in meeting the men of eminence and in discussing their special work.

The following names with comment as it appeared in the official programme are given in alphabetical order as of interest to the electrical and allied fields of endeavor:

Edward G. Acheson, Niagara Falls, N. Y.—The inventor of carborundum and of a successful process of making graphite.

Alexander Graham Bell, Washington, D. C.—The scientist who produced the first successful speaking telephone. Founder of the American Association to promote the teaching of speech to the deaf.

Eliphalet W. Bliss, New York city—Inventor and manufacturer of presses, dies and special machinery for working sheet metals; sole manufacturer of the Whitehead torpedo and appliances for the United States Navy, and president of the United States Projectile Company.

Alexander E. Brown, Cleveland, Ohio—Inventor and manufacturer of labor-saving machinery for the rapid and economical handling of materials at mines, docks, iron and steel plants, shipbuilding yards, structural works and railway terminals. The extensive use of his system in the United States has so reduced the cost of transportation by water and rail, and of labor at blast furnaces and steel works, shipyards and bridge works, that, although the rate of wages is the highest, the cost of labor per ton of product in the United States is now the lowest of any like industry in the world wherever this machinery is in use.

Charles F. Brush, Cleveland, Ohio—Scientist and inventor; founder of the American arc lighting industry.

John H. Converse, Philadelphia, Pa.—Representing the Baldwin Locomotive Works, now finishing its twenty thousandth locomotive.

Charles H. Cramp, Philadelphia, Pa.—For fifty years general manager of Cramp's shipyard.

Francis Bacon Crocker, New York city—Instructor and professor of electrical engineering at Columbia University, founder of the Crocker-Wheeler Electric Company; ex-president of the American Institute of Electrical Engineers, and author of several books and numerous papers on electrical engineering.

Thomas Alva Edison, Llewellyn Park, N. J.—The inventor, especially of the incandescent light system.

John Fritz, Bethlehem, Pa.—The Nestor of the iron and steel industries of America, beginning in 1838 with an annual production of 250,000 tons and ending with an annual production of 16,000,000 tons in 1901; identified with every important change in the process of making iron and steel which resulted in this increased production; founder, designer and builder of the great forge and armorplate plant of the Bethlehem Steel Company.

George J. Gould, Lakewood, N. J.—President of the Missouri Pacific Railway, Manhattan Elevated Railway, Western Union Telegraph and other companies.

Charles M. Hall, Niagara Falls, N. Y.—The inventor of the process of producing aluminum used by the Pittsburgh Reduction Company, at present the sole commercial producer of aluminum in the United States.

Samuel Pierpont Langley, Washington, D. C.—Astronomer and physicist. Established at the Allegheny Observatory in 1868 the railroad time service, since used throughout the country. Invented the bolometer, by means of which temperature measurements smaller than one-ten-millionth of a degree may be indicated. Has conducted laborious experiments in the problem of aerial navigation, which resulted in the construction of steel flying machines (*i. e.*, machines not lighter than air, as a balloon, but absolutely heavier), which have, for the first time, flown by steam very considerable distances. He is now secretary of the Smithsonian Institution.

John Markle, Jeddo, Pa.—Representative of the individual operators in the anthracite coal fields of Pennsylvania, and the largest of such miners and shippers. (President of the Sprague Electric Company.)

Albert A. Michelson, Chicago, Ill.—Head professor of physics at the University of Chicago and president of the American Physical Society. He has measured the speed of light (the result being now generally accepted as standard) and investigated the effect of the motion of the earth through space on the speed; showed how waves of light could be utilized as an exceedingly delicate and accurate method of measurement, as well as a powerful instrument of research; devised a method whereby a light wave may be made an absolute and invariable ultimate standard of length and devised a new spectroscope more powerful than any hitherto known.

Darius Ogden Mills, New York city—President of the Niagara Falls Power Company, the largest power development in the world. Large owner of mines and of real estate and the originator and owner of the "Mills Hotels" for self-respecting men of moderate means.

Charles A. Moore, New York city—Representative of Manning, Maxwell & Moore, the largest manufacturers in this country of machine tools and their principal distributer throughout the world.

Henry Morton, Hoboken, N. J.—Physicist. Organized Stevens Institute of Technology, and controller of its operations since.

William Barclay Parsons, New York city—Chief engineer of the Rapid Transit Commission.

Henry S. Pritchett, Boston, Mass.—President of the Massachusetts Institute of Technology and late superintendent of the United States Coast and Geodetic Survey.

Michael I. Pupin, New York city—Electrical inventor and professor of electromechanics at Columbia University, New York. The discoverer of multiple electrical resonance and of its application to multiplex telegraphy and telephony.

Ira Remsen, Baltimore, Md.—President of Johns Hopkins University.

Edwin Reynolds, Milwaukee, Wis.—Inventor of the Reynolds-Corliss Engine, president of the American Society of Mechanical Engineers, and chief engineer of the Allis-Chalmers Company, the constructors of the largest stationary steam engines.

Washington Augustus Roebling, New York city—Bridge engineer, vice-president of John A. Roebling & Sons Company, manufacturers of wire cables and builder of the Brooklyn Bridge and the new East River Bridge.

Charles M. Schwab, New York city—President of the United States Steel Corporation.

Coleman Sellers, Philadelphia, Pa.—Chief engineer of the Niagara Falls Power Company and inventor of machinery.

Frank J. Sprague, New York city—Electrical engineer, pioneer of the modern electrical railway and its multiple unit system of control and in the development of electric elevators in America and Europe.

Charles Proteus Steinmetz, Schenectady, N. Y.—Electrician, scientist and inventor, president of the American Institute of Electrical Engineers and engineer of the General Electric Company, largest producers of electrical apparatus in America; author of valuable treatises, papers and books on electrical engineering.

Nikola Tesla, New York city—Electrician, devoted to original research.

Elihu Thomson, Swampscott, Mass.—Electrician. A founder of the Thomson-Houston Electric Company, consolidated with the Edison interests in the General Electric Company and prominent as originator of many widely used inventions in electric lighting and power. Inventor of electric metal welding and working.

Robert H. Thurston, Ithaca, N. Y.—Consulting engineer, scientific investigator and inventor. Organizer and director of Sibley College. Founder of a laboratory of engineering research and organizer of the first distinctive curriculum in mechanical engineering in the United States.

Herbert H. Vreeland, New York city—President of the Metropolitan Street Railway Company.

George Gray Ward, New York city—Managing director of the Postal Telegraph and Commercial Cable lines and representative of the Deutsche Atlantische Telegraphen Company.

George Westinghouse, Pittsburgh, Pa.—Inventor, manufacturer, organizer, president of the Westinghouse Air Brake Company, Electric Company and Machine Company in the United States; and of associated British, French, German, and Russian air brake and electric companies.

Edward Weston, Waverly Park, N. J.—Electrician and inventor. Pioneer in American electric plating and arc and incandescent lighting. Inventor and designer of electrical measuring instruments now in use around the civilized world.

Peter A. B. Widener, Philadelphia, Pa.—Financier and operator of surface railways.

THE ENGLISH VERSUS THE METRIC SYSTEM.

BY CHARLES T. PORTER.

A bill is now before Congress, and is in danger of becoming a law, which will make the use of the metric system of measurement compulsory in this country. The Society of Mechanical Engineers is issuing an appeal to its members to exert their influence individually with representatives in Congress to prevent the passage of this bill. At this juncture it seems important to present to engineers generally the point here made, which appears to me to go to the root of the matter.

The bill is advocated on two grounds—first, that the metric is the only scientific system, and second, that it is generally adopted, and uniformity in this respect is of the first importance.

I have in previous writings pointed out the absurdity of this scientific pretension, showing that system of measurement to be only the decimal system, with a single arbitrary unit, different from the units employed by us, and to which single mode of division the metric system labors under the disadvantage of being limited.

I now propose to show further that the English system, employing several units, commensurable with each other, adapted to different uses, and each divided by continual bisection, while making no pretension in that way, is in reality in the highest sense scientific or philosophical, and this by reason of a feature which is wanting in the metric system, and the want of which renders that system unphilosophical, unnatural and inconvenient for the purpose of mechanical measurement.

We employ four units of linear measurement—the mile, the yard, the foot and the inch. Each one of these units has its individuality and a distinctive name. The same is true of the parts obtained by continual bisection. Each of these also has its individuality and distinctive name.

The problem always is, how can the idea of any distance or dimension be formed in the mind and conveyed to other minds with the greatest distinctness. The answer is obvious. We must employ the largest available unit of measurement, and supplement this, as required, by smaller units, employing the largest available division formed by continual bisection. When the reality can not be expressed in this way, then, and not till then, must we resort to the decimal system of division, the value of which, in this limited field, is beyond all estimation.

This mode of expression brings the distance or dimension before the mind with a definiteness which can not even be approximated in any other way. This advantage is possessed by the English system of measurement, and is retained by it to the utmost useful limit. Thus, we do not say 17,600 yards, but ten miles; we do not say 120 inches, but ten feet, and so universally. By employing the largest suitable unit we see the distance or the dimension as a vivid reality. We are enabled also to apprehend more clearly the relation to one another of the different members of any construction. We reach correct proportions more readily, are less liable to errors, either of design or figuring, and are more likely to detect errors if these are fallen into.

This system is in accord with the divisions of the circle and of time, which are universally employed. In the former we have three units—the degree, the minute and the second. In the latter we have centuries, years, months, weeks, days, hours, minutes and seconds. Each one of these units also has its individuality and its distinctive name. Here, too, we always employ the largest of these units that is applicable, and by this means, as is obvious to every one, the angle or the interval of time is properly expressed to us. Any other mode of expression would be ridiculous. The decimal system is not resorted to until we need it, to express divisions of the second, either of the second of arc or the second of time.

This principle of employing the largest available unit is recognized by the French, in adopting the kilometre (1,000 metres) as the unit for land measurement, and the metre as the unit for civil engineering work. Indeed, the French civil engineers have rather an advantage over our own, the metre being a larger unit than the yard.

But for the uses of the mechanical engineer all is reversed. Here the metric system bids defiance to this principle, and in place of the largest it substitutes the smallest unit, the millimetre (0.001 of the metre), nearly 0.04 inch, and all mechanical measurements are expressed in terms of this unit. Where we would write ten inches, the metric expression would be 0.40 millimetres, approximately, as the two measurements can not be expressed exactly each in terms of the other. Four feet eight and one-half inches is an illustration of our system of employing the largest unit, supplemented as already described. The definiteness of each item will be observed. The metric equivalent is 1,434 millimetres.

This system, in its application to mechanical measurements, presents a dreary monotony of abstract figures, while the draughtsman is in a state of constant anxiety lest he misplace his decimal point.

All this results from the fundamental error of employing the decimal system in a field to which it is not adapted.

It should be observed that, while our own decimal system is in decimals of an inch, we employ it in micrometer measurements only; sometimes, however, for convenience, writing in decimals the fractions obtained by continual bisection.

It will be seen that the philosophical superiority of the English system lies in the fact, that figures express realities of distance or dimension with a definiteness that in the metric system can not be approached. This is the secret of its greater convenience for mechanical measurements.

But uniformity! Everything, we are told, must be sacrificed to uniformity. I do not know why uniformity is of so much more consequence to us than it is to other people, that for it we must sacrifice what is priceless. Let other nations come to us. They have everything to gain by doing so.

There is also another view. English-speaking people have established the gauge system, about which other nations know nothing except what we have taught them. We have been at immense pains to obtain the ideal inch, with its divisions on the natural system of continual bisection, and its multiples, and their combinations, with the utmost exactness, as concrete realities. These are in universal use with us. All our mechanical construction is adopted to them. The universal screw-thread system, another Anglo-Saxon gift to the world, is founded upon them. All this also we are to be compelled to throw away. This would involve a loss and confusion, beyond all power to estimate.

This, however, is nothing, compared to the abandonment of the philosophical principle, on which our system of mechanical construction rests. How little do our legislators imagine what it is they are meddling with!

Is there not power enough in the English-speaking people to defend for their own mechanical engineers the invaluable principle of employing the largest unit of measurement, and, moreover, to make its application as universal for constructive work, as it is for everything else, for the civil engineer, for geographical measurement, for the circle and for time?

Electrochemistry and Electrometallurgy.

A Symposium before the American Institute of Electrical Engineers.

THE one hundred and sixty-second meeting of the American Institute of Electrical Engineers was held at No. 12 West Thirty-first street, New York, on the evening of Friday, February 28. The topic for the evening was "Electrochemistry—Electrometallurgy." Seven papers were presented as follows:

1. "The Electrochemical Industries." By Dr. Samuel Sheldon.
2. "The Electric Furnace in Industrial Chemistry." By Mr. Charles B. Jacobs.
3. "Electrolytic Recovery of Copper from Low Grade Ores." By Dr. Nathaniel S. Keith.
4. "Liquid Potentiometer; Determining Electrolytic Resistance with Direct-Current Instruments."
5. "Point of Cut-off in a Battery Discharge."
6. "Electrolytic Conduction without Electrodes." By Mr. Carl Hering.
7. "Colloids." By Mr. W. R. Whitney.

President Steinmetz made his usual luminous and analytical introductory address. He said:

Ten years ago hardly anything was in existence of the now very large industry of electrochemistry. To-day a very considerable part of the world's water powers are utilized in this direction. No insignificant part of the total output of valuable metals is produced by electrochemical means. What, ten years ago, were laboratory curiosities are now substances in common and daily use, as for example, carbide of calcium and aluminum. New substances have been introduced and a new art has grown up around the electrochemical and electrothermal aspects of electrical engineering.

In many of the processes of electrochemistry only direct current is used today. The various methods of depositing metals from solutions at present absorb very large amounts of current at low voltage. In electric furnace work practically only the heating effect of the current is used and no direct chemical action can ordinarily be ascribed to the current itself. Mr. Steinmetz spoke of the arc furnace and the incandescence furnace and said that while the two were somewhat similar they are by no means interchangeable. At the temperatures which are produced in the electric furnace chemistry as we know it in the ordinary laboratory practically ceases to exist, and a whole company of new actions and phenomena are called into play. In the incandescence furnace any degree of temperature up to that determined by the disintegration of the materials of the furnace and electrodes is attainable. Indeed, the electric furnace is the only method of attaining what may be called transcendental temperatures.

Notwithstanding the enormous cost of electrically produced heat it is finding application in many directions, either where temperatures beyond the range attainable by combustion are necessary, or where a very accurate regulation of heat is desired. To-day the electric furnace of the heating variety is almost invariably operated by alternating currents on account of the ease of generation, transmission and transformation exhibited by this variety of electrical activity. Mr. Steinmetz also called attention to the extraordinary and beautiful phenomena of the Crookes tube, and described at some length the promise which was held out by this most extraordinary means of exhibiting electrical action upon matter.

Before any papers were presented, M. Maurice Leblanc, of Paris, a member of the Société Internationale des Ingenieurs Electriques, and one of the best known electrical engineers in France, was introduced and welcomed by President Steinmetz and given the freedom of the Institute.

The papers given in the list above were presented in their due order, generally in abstract.

M. Leblanc was requested to address the Institute. M. Leblanc spoke in French. He said:

"Among the greatest regrets which have come to my later life is that I have not fully mastered the English language. Yet I know sufficient of it to have followed with interest and pleasure the reading of the various papers presented this evening dealing with the important subject of 'Electrochemistry.' In my visits to the United States I have found unusual pleasure and profit. I can not pass this opportunity to express my admiration of the immensity of American electrical enterprises. On every hand I see the evidences of astonishing development.

"In France, we can not exhibit so great an extension of electrical engineering works as you have here, but I think we can show at least an equal desire to advance the general progress of this branch of engineering, and I am sure that those of you who visit us there will receive, in some measure at least, the kindly hospitality which I find invariably extended here to the visiting engineer. I thank you, gentlemen, for this opportunity to address this Institute."

The discussion was opened by Mr. C. S. Bradley, who spoke at some length concerning the methods of experiment which he had found of value. He said that the subject was one of peculiar difficulty, because there entered into it always the personality of the men conducting the experiments. Evolution had not yet been entirely understood, and certainly had not so far been applied to business matters. While to a certain degree it was understood by scientific men the deductions and formulæ of the theory had not, so far, reached down into the business world. Notwithstanding this, he felt that the principles formulated by Darwin and Spencer applied as well to the organic evolution of a business as to that of a species of fish or animals.

In experimentation the first necessity is the man, the second is a little money and after that a laboratory. By "little money" he meant really a little, because the wise expenditure of a small sum of money would give the basis of a process, and afterward companies could be formed which might be nuclei of the industrial evolution. More work would call in more capital; more capital would give room for more work, and so on indefinitely. When the experimental stage has been safely passed and some new method or synthesis has been developed the necessity arises for a corps of men to conduct the business end of the enterprise. As a general thing, employers are loath to employ enough men. Men should work at this kind of experimenting without the necessity of immediately apparent result, because time generally tells and results often come from work that appears at first fruitless.

Mr. Bradley spoke facetiously about the reasons why the whole truth of any industrial process could not be told. He entered at some length into the morals of business and the technique of "throat-cutting" as practised in business affairs.

Referring to Dr. Sheldon's paper, he stated that the method employed in the manufacture of synthetic camphor was first the treatment of turpentine by oxalic acid. The result of this was pinin oxalate. This substance being treated with quicklime produced calcium oxalate and free "borneol." The latter being heated and condensed was discovered to be a dextrose camphor. When properly treated—and the nature of the treatment was not indicated—this was turned into lævulose or ordinary camphor, identical in all respects with the natural gum.

Mr. Bradley thought that the chances for electrical applications in organic chemistry were comparatively small.

Mr. Calvin W. Rice called the attention of the members present to the recent luncheon in honor of Prince Henry of Prussia, at which were assembled some ninety odd American "captains of industry." Of these no less than six were former presidents of the Institute, four others were members and two others were prominent men identified with electrical interests.

Dr. C. A. Doremus spoke at length of the importance of scientific work and entered into an elaborate discussion of the paper by Professor Whitney.

Dr. N. S. Keith described various varieties of electrolytic cells. Messrs. W. R. Whitney and E. P. Thompson spoke briefly, and Mr. C. J. Reed described at some length experiments recently undertaken by himself on the migration of ions. He stated that he had been led to believe that the movement of ions in an electrolytic solution is not necessarily dependent upon current flow, but to no small degree is determined by the presence and nature of the electrodes. Mr. Carl Hering and President Steinmetz closed the discussion.

The meeting was one of the most interesting and one of the best attended in the recent history of the Institute.

THE ELECTROCHEMICAL INDUSTRIES.

BY SAMUEL SHELDON.

Introduction—In this paper an attempt is made to give a general view of the present condition of the electrochemical industries. The subject of storage and primary batteries is so large and is so clearly differentiated from the other electrochemical industries that it is not touched upon. The subject of electrotyping is also not considered. The carrying on of the other industries requires over 200,000 horse-power. Of this about ninety per cent is obtained from water power. The cost of electrical power, obtained from water power, varies much in different parts of the world. Swan gives the limits per horse-power year as $5 and $50. At Niagara the price to large consumers is about $17. This power is delivered in Buffalo for about $30.

ELECTRODEPOSITION OF METALS.

Electroplating—The methods of plating employed in establishments in the vicinity of New York do not differ to any extent from the methods well known in the art. The average practice may be described as follows:

Gold—There are three solutions in common use to give the three colors of deposit known as "California gold," "green gold" and "red gold." The salts to form the solutions are prepared by dissolving, in nitro-hydrochloric acid, the following alloys: For California gold an alloy of twenty-two parts gold and two parts silver, for green gold an alloy of sixteen parts gold and eight parts silver, and for red gold an alloy of sixteen parts gold and eight parts copper. Upon evaporation the chlorides of these metals remain. They are dissolved in a solution of potassium cyanide to form the plating solution. Double cyanides are thus formed. A freshly prepared solution contains a pennyweight of gold to the gallon. The anodes are of pure gold. The articles to be gilded form the cathodes. The rate of solution of the anode is not as great as the rate of deposition on the cathode. Therefore, the solution has to be enriched by frequent addition of the salts. The current density is adjusted by varying the depth of submergence of the anode, the baths being supplied with five volts at constant potential. The correctness of the current density which is being employed is determined by the eye and the experience of the attendant. There is no circulation of the electrolyte.

Silver—The solution consists of a double cyanide of potassium and silver, the concentration being two ounces of silver per gallon of solution. The anodes are of pure silver. Owing to the tendency of silver to deposit in arborescent crystals, the articles which are being plated are moved backward and forward in the bath in a plane parallel with the anode surface. The path of movement is about two inches and the time required to traverse it about three seconds. The proper current density rests with the judgment of the attendant. Too great a density or an impoverished solution is indicated by a violet tinge imparted to the deposit. Silver-plated articles to have a polished finish require burnishing with steel or blood-stone burnishers moistened with a solution of soap and distilled water.

Nickel—The solution universally employed is one of nickel-ammonium sulphate. The proper concentration results from dissolving eight pounds of the salt in a gallon of water. The solution should be kept neutral by the addition of either ammonia or sulphuric acid. The proper current density is from 0.5 to 1.5 amperes per square decimetre of cathode surface. Nitric acid should not be present in any form in the solution.

Brass—Much house or builders' hardware consists of brass-plated steel or iron. Many solutions are used. The best, perhaps, contains equal quantities of zinc and copper cyanides or carbonates dissolved in ammonium carbonate. The color of the deposit can be varied by varying the relative amounts of the copper and zinc salts.

Critical Current Density—In the electrodeposition of metals from a salt solution the rate of deposition, which may be used, is limited. If a proper current density at the cathode be employed, an adherent reguline deposit will result. If the current density be increased, a limit is reached, when, if exceeded, the character of the deposit will change, becoming pulverulent and non-adherent. This limit is termed the critical current density. As an increase of the permissible current density allows of a smaller plant for the same output and shortens the time that the metal in the solution is idle, a consideration of the factors, which determine the value of the critical current density, is pertinent. Consider a cubic centimetre of metallic salt solution at rest, and directly in front of a cathode. It contains a certain weight of the metal. This weight is dependent upon the concentration of the solution and can be calculated from its specific gravity. A certain percentage of this metal, dependent on the temperature and concentration of the solution, is dissociated and takes part in the electrolytic conduction. If an attempt be made to so adjust the current, flowing through this cubic centimetre, that by Faraday's laws the rate of deposition is such that all the dissociated metal ions must be deposited in one second, then, it is evident, the velocity of movement or migration of the ions would be one centimetre per second. Such a rate of deposition of ordinary metals from a stationary solution

is impossible. The maximum velocity of migration is rather to be reckoned in thousandths of a centimetre per second. If the deposit is to remain reguline, the ions must not be expected to migrate faster. It is possible, however, to adjust the circuit for any current density. As soon as the rate of deposit exceeds the ability of the metal ions to supply it, hydrogen of the solvent appears to take part in the conduction and a pulverulent deposit results, which contains some hydrogen and is said by some to be a hydride of the metal. The critical current density can be increased by increasing the concentration of the solution, by raising its temperature, or by circulating the electrolyte toward the cathode.

Circulation—Circulation of the electrolyte has three functions. It permits of a higher rate of deposition, as mentioned above; it replenishes the part of the electrolyte next to the cathode which has been deprived of its metal; and it prevents, to a certain extent, the deposit from assuming a nodular or arborescent form. When deposition is taking place at moderately large current densities, accidental differences of concentration occur in the vicinity of the cathode. Places on the cathode, which can be reached by current flowing through the more concentrated portions of the electrolyte will receive a heavier deposit than other places. As a result, they will protrude slightly from the cathode. These unevennesses are multiplied and magnified as the deposition continues.

Dissociants—The water of an ordinary electrolyte performs two duties. First, it acts as a solvent, whereby it allows and facilitates the uniform distribution of the dissolved substance throughout the solution, subdivision of the substance being carried to a condition of a molecular fineness. Secondly, it acts as a dissociant whereby some of the molecules of the dissolved substance are split up and dissociated into their component ions. Without dissociation there can be no electrolytic conduction of the current. Besides water the following substances are common solvents and dissociants: Liquid ammonia, ethyl alcohol, methyl alcohol, glacial acetic acid, and pyridin. The last named contains no oxygen, and it has been recently shown by Dr. Kahlenberg that from a solution of lithium chloride in it, pure metallic lithium may be electrolytically deposited.

Copper Refining—Refined copper constitutes the most valuable product of all the electrochemical industries. The processes of producing the refined copper from its alloys have been well described by Badt in the ninth volume of the Institute's published Transactions. The copper alloy or blister copper is cast into slabs which are used as anodes in a bath containing a slightly acidulated solution of copper sulphate. This electrolyte is kept in continuous circulation. Pure copper is deposited from the solution upon pure copper cathodes at a current density of from fifteen to twenty-five amperes per square yard. Copper is simultaneously dissolved at the anode, and the alloyed gold, silver, and other metals drop, as slime, to the bottom of the cell, to be parted and recovered later. After deposition the cathodes are melted up, poled, and cast into wire-bars or other suitable forms. The "poling" of copper consists in stirring the molten metal with a pine stick. The stick carbonizes, and, as a result, reduces cuprous oxide which is present in the molten copper. Upon cooling, cuprous oxide gives up its oxygen to metallic impurities which may be present in the copper. As the mechanical and electrical properties of copper are better when impurities exist in the form of oxides rather than as metals, the proper amount of poling is when just sufficient cuprous oxide is left to oxidze the impurities. Overpoled or underpoled copper is brittle and of inferior conductivity.

Parting of Gold and Silver—This is accomplished by means of electrolysis very satisfactorily in the following manner: The alloy of the two metals constitutes the anode, and is placed in a linen bag. The cathode is a thin sheet of pure silver. The electrolyte is at first a one-tenth-per-cent solution of nitric acid, which ultimately becomes a dilute solution of silver nitrate. With a current density of thirty-three amperes per square foot, silver 999.5 per mil fine is deposited on the cathode in the form of beautiful crystals. These are mechanically scraped off and allowed to drop to the bottom of the cell. Gold, in the form of mud, containing some silver collects in the anode bags. The silver is removed from it by dissolving in nitric acid, leaving the gold in a very pure condition.

Extraction of Gold—The process of Siemens and Halske, which is in use in South Africa, consists in dissolving the gold from the crushed ore in solution of cyanide of potash and then subjecting the solution to electrolysis with iron anodes and thin sheet-lead cathodes. The anodes are dissolved. Dr. Keith improves upon this process by adding a small amount of soluble mercury salt to the cyanide solution. It increases the rapidity of solution, and mercury is deposited alongside of the gold on amalgamated copper cathode plates. The amalgam is scraped from these plates and the gold and mercury separated by "retorting."

Extraction of Nickel—By the Hoepfner process the nickel ores are first roasted, crushed and leached in a mixed solution of cuprous chloride and calcium chloride. By electrolysis with carbon electrodes the copper is removed from the solution. The lead and iron are removed by chemical means. There then remains a solution of nickel chloride. This is electrolyzed, and the nickel deposited upon a nickel cathode.

INORGANIC PRODUCTS.

Alkalies and Bleach—The power employed in the electrolytic preparation of these substances amounts to more than 50,000 horse-power. There are many different processes employed, some of which are secret. The electrolyte is always common salt, either in water solution or in a fused condition. Upon passage of a current, using a carbon anode, chlorine is developed in the gaseous form at the anode and is lead to chambers containing lime with which it forms bleaching powder. Metallic sodium appears at the cathode. If the cathode be mercury, as in the Castner process, a sodium amalgam is formed, which, upon washing with water, yields caustic soda and returns the mercury. If the cathode be iron, in a water solution, caustic soda is developed by secondary reaction. In the Acker process the electrolyte is fused salt and the cathode is molten lead.

Sodium—This is manufactured on a commercial scale at Niagara by the electrolysis of fused caustic soda. The electrolyte is maintained in a fused condition by the current which passes through it. An iron containing-vessel constitutes the cathode and the anode consists of rods which dip into the electrolyte. The sodium after deposition rises to the top of the electrolyte and floats upon its surface. As it accumulates it is removed by small iron dippers. The sodium, after its reduction, is used in the manufacture of sodium dioxide. This is done by spreading the metallic sodium on trays, which are placed in tubes, that are supplied with air, dried over calcium chloride. The sodium peroxide is then used for producing peroxide of hydrogen. For this purpose it is mixed with sulphuric acid, and during the mixture the temperature is maintained near zero by melting ice. This is necessary because of the unstable character of the peroxide of hydrogen.

Aluminum—This metal is reduced elec-

trically from alumina by the Pittsburgh Reduction Company, at Niagara Falls, in America, and at Shawinigan Falls, in Canada, and by six other firms in Europe. The annual product in America is about 3,000 tons. Kershaw estimates the total output for 1901 as 7,500 tons. The double fluoride of aluminum and calcium in a fused state is used as a solvent and dissociant. The heat developed by the passage of the electrolyzing current maintains the solvent in a fused state. The electrolyte is contained in large cavities made in carbon slabs. The carbon constitutes the cathode and groups of large carbon rods, dipping into the fused electrolyte, constitute the anodes. The metal is drawn off once a day through taps leading to the bottom of the cavities. As the electrolyte is deprived of its metal its resistance rises. This fact is utilized to give warning to attendants. An incandescent lamp is shunted between the electrodes and, as the resistance of the electrolyte rises, the brilliancy with which the lamp burns increases. The attendant then introduces fresh alumina to the fused electrolyte. The process is thus continuous and uninterrupted.

Sponge Lead—This is produced from litharge by placing it in contact with a sheet-lead cathode in an electrolytic cell having a lead anode and dilute sulphuric acid as the electrolyte. The deposited hydrogen reduces the litharge, leaving a lead sponge of fine quality. This process is employed by the National Battery Company, at Buffalo. The Electric Lead Reduction Company, of Niagara Falls, is also producing sponge lead by subjecting galena to electrolysis.

Potassium Chlorate—This is manufactured in considerable quantities by the National Electrolytic Company, at Niagara Falls, by the electrolysis of a solution of potassium chloride. The process is not ideal as compared with many other electrolytic processes, and the yield is not as great as could be desired for the electrical energy which is employed. The yield is increased by introducing a small quantity of potassium chromate into the electrolyte as shown by Müller, and the introduction of a little alumina neutralizes the potassium by hydrate as it forms at the cathode. The cathodes, as used at Niagara, are of wire gauze covered with cuprous or cupric oxide. The reduction of the oxides by the liberated hydrogen develops sufficient heat to maintain the temperature of the electrolyte at fifty degrees centigrade. The electrolyzed solution is led into refrigerating tanks, where the chlorate is made to crystallize by lowering its temperature.

Ozone—This gas is a modified form of oxygen. It is generally stated that a molecule of ozone contains three atoms of oxygen, while a molecule of gaseous oxygen contains but two atoms. This, however, is uncertain. Ozone differs from ordinary oxygen in being a much more powerful oxidizer at ordinary temperatures. It very quickly oxidizes organic substances. Ordinary rubber becomes brittle and crumbles after an immersion for a short time in the gas.

There are many forms of apparatus devised for the electrolytic production of ozone. The general principle underlying the construction of all of them is to pass a stream of dry oxygen or air between two conducting surfaces which are close to each other. The conductors are subjected to differences of potential which are rapidly varied in amount over wide limits. The high tensions of electrostatic machines, induction coils, or transformers are used. Disruptive discharges may be employed for producing the rapid change of potential difference. One company is using an alternator which gives 10,000 cycles per second. The issuing gas is said to be ozonized. At best it contains but little above one per cent of ozone. A molecule of oxygen, consisting of two atoms, each bearing an electric charge, when subjected to the sudden variations in the electrostatic field between the conductors, may in some or many cases be torn apart. The constituent parts may join with other molecules of oxygen to form ozone molecules.

Ozone is used on a commercial scale in yielding organic oxidation products, in sterilizing water for potable purposes and in bleaching fabrics. Among its proposed uses may be mentioned the decoloration and defecation of syrup in sugar manufactories, the ageing of wines and the ageing of woods for the construction of such musical instruments as violins.

Nitric Acid—One firm, which is interested in electrochemistry, has perfected a method for the electrolytic production of nitric acid, the nitrogen being recovered from the atmosphere. The electrical process very materially reduces the cost of production. The importance of such a process may be very great in the future. Nitrogen is essential in the diet of all the higher forms of animal life. Soils are deprived of their nitrates by the crops which are grown. The supply is replenished to some extent by parasites which grow in nodules on the roots of leguminous plants. These parasites are capable of taking nitrogen from the atmosphere and oxidizing it. And yet fertilizers containing nitrates have to be applied to the soils to maintain their productiveness.

ORGANIC PRODUCTS.

Several hundred organic substances have been prepared in the laboratory by means of electrolysis. Most of them remain as laboratory preparations, but some have come upon the market, being manufactured on a commercial scale. All these organic products may be arranged in four classes, depending upon the ultimate constitution of the substance yielded as compared with the composition previous to electrolysis. Without considering the actual electrolytic process, the effective process is either one of oxidation, of reduction, of concentration or of substitution or addition. These processes, like all electrical processes, are especially valuable because of the extreme delicacy of regulation which is possible. The efficiency of the process as regards yield is thereby increased.

Electrolytic methods constitute a valuable addition to the facilities at the disposal of the organic chemist. In carrying on experimental work, attention should always be given to the temperature, to the concentration, and to the current density which is being employed.

Iodoform—This is prepared by the electrolysis of ethyl alcohol in a solution of sodium or potassium iodide. The anode is of platinum and is placed in a solution made of fifteen parts of potassium iodide, 100 parts of water, and sixteen parts of ethyl alcohol. This solution is separated by a porous diaphragm from a strong solution of sodium hydroxide, which contains a nickel cathode. The temperature of the electrolyte is kept at seventy degrees centigrade and a current density of one ampere per square decimetre is employed. After passage of the current for three or four hours, the solution is allowed to cool and iodoform crystallizes out.

Chloroform and Bromoform—It is claimed that by substituting chlorides or bromides for the iodides in the above process either of these two substances may be prepared.

Camphor—If turpentine hydrochloride, in a melted condition or in an alcoholic acetic acid solution, be electrolyzed, camphor is obtained. Camphor results from the oxidation of terbene, *i. e.*, oil of turpentine. Artificial camphor is made from turpentine in large quantities by the Ampere Electro-Chemical Company, but the process is claimed to be in nowise electrical.

Vanillin—This substance, which is the odoriferous component of vanilla, is obtained by the oxidation of eugenol (oil

of cloves). It is much used in the manufacture of perfumes. It is produced electrically on a commercial scale in France.

Artificial Rubber—A process for the electrical production of artificial rubber is being experimented with, and it is said to promise much for the future. No details concerning the method are being given to the public.

FURNACE PRODUCTS.

The electric furnace owes its great utility to the facility with which its temperature can be regulated and especially to the great elevation of temperature which is obtainable. The amount of heat which is produced in a conductor is dependent upon the resistance of the conductor, the strength of the current, and the duration of the current flow. All of these are easily altered in magnitude. The temperature of the conductor is determined by the rate of development of heat and upon the facility which is offered for its escape. The ultimate stationary temperature is attained, when the rate of escape of heat is equal to the rate of its production. With a given rate of heat production the temperature rises as the facility for the escape of heat is lessened. The many available heat insulators make it possible to produce any temperature which can be withstood by the conductors.

Calcium Carbide — This substance, which is prepared by heating a mixture of coke and lime in an electric furnace constitutes, at present, the most valuable electrochemical product with the exception of copper. Furthermore, its production requires more power than any other electrochemical industry. Kershaw estimates that in 1900 the power employed was 85,000 horse-power. The rate of production has been in excess of the rate of consumption and the result has been a decrease in the price of the product.

Its value lies in the fact that, when placed in water, acetylene gas is developed to the extent of about five cubic feet per pound of carbide. When burned in air the acetylene gives a flame of great intrinsic brilliancy and of pleasing color quality. Its richness in carbon tends toward a sooty flame. Swan inclines to the belief that the gas may prove of great value in metallurgy as a reducing and carbon-carrying agent.

Calcium carbide is put in the class with explosives and dangerous chemicals. It is, therefore, subject to high freight rates for transportation and is associated with high insurance rates. Owing to the moisture ever present in the atmosphere it suffers from freight transportation over long distances. These facts militate somewhat against its adoption as a source of illumination for small towns.

Carborundum—This substance is carbide of silicon. It is an abradent, harder than emery, and is used for the same purposes as the latter. It is made into wheels, into tools of various forms, and into hones. The process of manufacture consists in heating electrically to a very high temperature, a mixture consisting of sixty per cent pure sand and forty per cent powdered coke. To this mixture is added a small amount of common salt, and sufficient sawdust to render the mass porous, so that gases, which are liberated in large quantities, may escape. This mixture is packed around a "core" of coarse granulated coke, the grains having diameters of from one-quarter inch to three-eighths inch. An alternating current is sent through the core and produces heat, which does not easily escape through the surrounding mixture. The result is a great temperature elevation and the formation of the carbide, some of it being in the form of very beautiful violet colored crystals.

Artificial Graphite—Upon the common introduction of arc lighting it was noticed by many observers that the tips of remnant carbons were transformed into something resembling graphite. The transformation extended only over the portions of the tips which had been heated, in the lamp, to a high temperature. In the manufacture of carborundum it was observed that there was always produced a layer of graphite in the hottest part of the furnace. Upon investigation the conclusion was reached that graphite was not formed by merely heating pure carbon to a high temperature, but that a carbide must be first formed and afterward be decomposed by the electric furnace heat. Therefore, it is necessary to have some metallic salt or oxide mixed with the carbon before heating. In practice a good mixture consists of ninety-seven parts of finely divided amorphous carbon commingled with three parts of iron oxide. This mixture permits of moulding into any desired shape which is afterward graphitized. The moulded articles are placed inside of a hollow carbon cylinder of about twenty feet in length and twenty inches in diameter. Current is sent through the cylinder in a longitudinal direction. As the articles become graphitized they acquire a greater conductivity, and the current which flows under a given impressed voltage increases accordingly. In practice the original impressed voltage is about 150 and the amperage about 300. As the graphitization proceeds the voltage is decreased, although the amperage increases.

Barium Hydrate—The United Barium Company is manufacturing about sixty tons per day of this substance at Niagara. It is in the form of large crystals of an inch or more length on the edge. The manufacture by the electrical method has reduced the price of the product to one-quarter what it previously was. It is consumed in large quantities in the manufacture of pigments, in the purification of water and in the recovery of sugar from beet molasses. In the last case a ton of hydrate is consumed in the recovery of a ton of sugar. The hydrate is made from crude barytes, this being the only natural source of barium. One equivalent barytes is mixed with three of barium sulphate, and the mixture is heated in an electric furnace. SO_3 is driven off in the form of vapor, leaving barium oxide behind. This oxide, upon being placed in water, becomes hydrated. It is then allowed to crystallize.

Barium Cyanide—This is manufactured by the Cyanide Company at Niagara. It is used in the production of the other cyanides. Barium carbide, a substance which is the analogue of calcium carbide, is mixed with coke, and producer gas is passed through the mixture while it is being heated electrically. The carbide has an unsaturated molecule, and the three free bonds of each carbon atom easily take an atom of nitrogen.

Phosphorus—This is manufactured by the Oldbury Electrochemical Company. The electrical process is practically the same as the chemical process, except as to the method of applying heat. Calcium phosphate, either in the form of bones or of natural rock phosphate, is pulverized, mixed with coke and placed in an electric furnace. Upon passing current through the mixture, the phosphorus becomes vaporized and is collected under water. The electrical process is cheaper than the older chemical one. This is because of two reasons. The temperature necessary to vaporize the phosphorus is quite high. There is, therefore, a large loss of heat when it is applied to the outside of the closed retorts containing the phosphate. This loss is not present when the heat is produced electrically inside of the retort. Again, the practice of the older process was attended with much breakage of retorts, which is absent in the case of the newer.

Corundum—The Norton Emery Wheel Company is manufacturing five tons per day of this artificial emery, which differs from the natural emery in being absolutely pure and of uniform specific gravity. The

natural variety lacks these two qualities which are essential in the manufacture of a perfectly satisfactory emery wheel. The process of production consists simply in the heating of bauxite in the electrical furnace until water is driven off and the remaining alumina becomes molten. Upon cooling this latter assumes a crystalline form.

Iron and Steel—There are a number of experimental plants in various parts of the world manufacturing steel directly from iron ores by means of the electric furnace. None of them has, however, passed the experimental stage. A number of alloys of iron, which are found useful and valuable in the manufacture of steel, are made in considerable quantities by means of the electric furnace. Among these may be mentioned ferro-chromium, ferro-titanium and ferro-silicon. The first was used in the manufacture of armor plates intended for the cruiser made in this country for the Russian Government.

Silicides—A very interesting line of substances has been produced by the Ampere Electro-Chemical Company, by means of the electric furnace, which it has termed silicides. They are the analogous to the carbides. Especially interesting is silicide of barium, which decomposes when placed in water with a development of hydrogen gas.

MISCELLANEOUS.

Electrolytic Condensers—If two carbon electrodes in a solution of zinc sulphate have impressed upon them a small difference of potential, a current will flow until the counter electro-motive force of polarization, resulting from the deposition of zinc on the cathode, is equal to and opposes the impressed electro-motive force. Upon removing this latter electro-motive force without opening the circuit, an inverse current will flow until the zinc has been redissolved. Such a combination constitutes an electrolytic condenser, its charge being the quantity of electricity associated with the deposited zinc. Its capacity is this quantity divided by the polarization electro-motive force produced by it. This capacity is very large and increases with the area of the submerged portions of the cathode. Such condensers can not be utilized with potential differences in excess of the maximum polarization electro-motive force. They are also very inefficient, due to leakage currents necessary to compensate for local action. For use with higher voltages cells may be used in series. For the same volt-ampere capacity electrolytic condensers occupy about the same space as ordinary condensers of paraffined paper and tinfoil. They have all the disadvantages associated with liquids.

The Electrolytic Rectifier—This device in its latest form, as designed by Pollak, consists of an electrolytic cell containing a slightly acid solution of potassium phosphate as an electrolyte. One electrode is of plain lead and the other is of aluminum, which has been formed by macerating it for some time in a solution of caustic soda. If the pressure on a circuit, in which this cell is connected, does not exceed 200 volts, and the temperature of the electrolyte be under forty degrees centigrade, then the cell will allow current to pass through it from lead to aluminum, but not in a reverse direction. This action is due to the formation of an insulating skin of aluminum hydrate over the surface of the aluminum when it is functionating as an anode. By means of such a cell one lobe of an alternating-current cycle can be extinguished. The life of a formed aluminum plate is about 500 hours. The skin then breaks down and separates from the plate.

Electrolytic Interrupters—The Wehnelt interrupter consists of an electrolytic cell with dilute sulphuric acid as an electrolyte, with a plain sheet lead cathode and with an anode of platinum wire, exposing a small surface (say 1/4 cm^2). The Caldwell interrupter consists of a cell, with almost any electrolyte, with both electrodes of carbon, lead or other suitable material, the cathode with its surrounding electrolyte being separated from the anode and its surrounding electrolyte by an insulating diaphragm containing one or more minute perforations. Upon introducing either of these interrupters into a circuit a series of sudden interruptions of the current will occur. These are due to the evolution of non-conducting gases around the platinum wire in the one case and in the diaphragm perforations in the other case. After interruption the circuit closes again as soon as the gases arise due to their buoyancy. The frequency of interruption can be easily regulated. It increases with increase of impressed voltage, with decrease of inductance and resistance in the circuit, with decrease of exposed anode surface, and with increase of hydrostatic pressure at the place of interrupting gas development. When properly designed and used in the primary circuits of induction coils, these interrupters produce remarkable results. The suddenness with which the magnetic flux which is linked with the secondary can be made to disappear is responsible for the high electro-motive force developed. The great amount of energy localized at the point of interruption of the circuit is destructive to the surrounding insulation. Lava is employed with considerable success.

United States Navy Experiments with Wireless Telegraphy.

The United States Navy Department has ordered a complete outfit for two stations of the wireless telegraph system of Herren Slaby and Arco from the Allgemeine Company, of Berlin. It is intended to use this outfit in competitive tests with the Marconi system.

Electricity for Swiss Railways.

In an interesting communication from Henry H. Morgan, Consul at Aarau, Switzerland, it is stated that a short time ago the representatives of the five largest electrical engineering companies of Switzerland held a meeting at Olden, at which the question of replacing steam with electrical power on the Swiss railway system was discussed. The representatives of a firm which makes a specialty of the construction of turbines (having lately received a large order to provide turbines for Niagara Falls) proved by scientific demonstration that the power which could be derived from Swiss waterfalls would be sufficient to provide enough electrical force for the entire railway system of the country.

It was decided to follow the example of Germany and constitute a society, composed of all the companies interested, which will furnish the funds necessary to investigate the subject.

The *Aargauische Nachrichten*, commenting on the project, says: "The Swiss Government, which will within a few years be the owner of all the great Swiss railway lines, is aware of the importance of the plan, and competent officials have expressed the opinion that the authorities will not fail to largely subsidize the intended experiments. The question of rendering Switzerland more and more independent of foreign coal by transforming her water power into electricity is of vital importance for the country."

The exports of metallurgical products from Germany last year amounted to 2,347,241 tons, as compared with 1,548,558 tons in 1900, 1,509,887 tons in 1899, 1,626,130 tons in 1898, and 1,392,952 tons in 1897. The imports of metallurgical products into Germany last year amounted to 400,659 tons, as compared with 983,112 tons in 1900, 839,839 tons in 1899, 523,808 tons in 1898, and 564,745 tons in 1897. The excess of exports over imports last year was, accordingly, 1,946,584 tons, as compared with 565,446 tons in 1900, 670,048 tons in 1899, 1,102,322 tons in 1898, and 828,208 tons in 1897.

THE PRESENT STATUS OF ELECTRICAL ENGINEERING AND INDUSTRY IN FRANCE.

AN INTERVIEW WITH M. MAURICE LEBLANC.

M. Maurice Leblanc, one of the best-known electrical engineers in France, and long the associate of M. Hutin in the invention and design of electrical apparatus, particularly of alternating-current apparatus, arrived in New York last week on his way to visit points in the interior of the country, and was a guest of the meeting of the American Institute of Electrical Engineers last Friday night.

At an informal luncheon on Saturday, M. Leblanc spoke at length and very entertainingly of the present condition of electrical interests and engineering in France.

The industrial depression which has been felt with more or less intensity throughout the continent of Europe has not passed by France. Indeed, the shrinkage in the value of electrical securities, of those representing interests in both manufacturing and operating companies in France, has been so great as in some measure to alarm investors; so that just at present no very great deal of new work is being undertaken. Perhaps the most interesting developments that are now going on in that country are, in M. Leblanc's opinion, the operation of heavy railways in the prolongation of the Orleans Railway Company's system in Paris and in the underground Metropolitan railway.

Both of these, said the distinguished visitor, are in extremely successful and satisfactory commercial operation. On the Orleans line was a situation of extreme difficulty. The terminal station of this railway company in the city of Paris was on the bank of the River Seine at some distance from the centre of the city, and at a point by no means convenient of access. It was determined to continue the line about two miles, in a tunnel parallel with the river and for the most part laid directly under the quais or wharves lining one side of the stream, to a great terminal station at the Quai d'Orsay. Since much ventilation of this tunnel was practically impossible, it was necessary to utilize electricity as the method of operating trains in it. The conditions form a somewhat singular parallel to those obtaining at the Grand Central Station and terminals in New York city, since the Orleans railway has a very large suburban passenger business requiring the operation of a great number of trains, particularly during the hours of extreme "rush."

The system used is the generation of current at high pressure upon the three-phase system and its distribution to the working of a third-rail conductor utilizing the ingenious rectifiers of Hutin and Leblanc. These machines, which seem not to be known to any degree in this country, take the place of rotary converters.

"The function of these machines," said M. Leblanc, "is to combine in one piece of apparatus the different operations of transformation in voltage and conversion from polyphase to direct current. In effect the machine consists of a ring transformer in which the primary is tapped at equal intervals corresponding in number to the number of phases in the supply circuit. The secondary, also ring-wound, is led out by a large number of equally distributed taps to the bars of a commutator on which are turned brushes driven by a synchronous motor. From these the direct currents are taken off. The advantage of the machine is naturally a saving of space and material and the lightening of the revolving parts. The operation of these apparatus," continued M. Leblanc, "has been extremely satisfactory, and they work in parallel without difficulty. Machines as large as 1,400 kilowatts have been constructed on this principle and are in successful commercial operation."

Speaking of the telephone situation in France, M. Leblanc said that conversation on the long-distance lines between Paris and Marseilles was excellent, but that on the Paris-Berlin line was apt to be sometimes difficult when the weather conditions were not of the best. He related a curious incident; he said that when Dr. Pupin's invention of a method of improved telephone circuits was made public, it was claimed that the same thing had already been designed and experimented upon by two officers of the government telephone service in France. Upon enquiry as to why no publicity had been given to this remarkable and very valuable invention, M. Leblanc said that the matter had been duly written and duly sent, as was proper, to the proper government bureau, and there, as was entirely usual (he supposed in this government as well as in all others), had been pigeon-holed and immediately forgotten. The telephone, he said, is growing largely in favor in France and is coming more and more generally into common use, not only in Paris but for long-distance conversations throughout the republic.

M. Leblanc was greatly struck and impressed with the immense application of electricity made in this country, and particularly so with the conditions surrounding existence in a large office building in New York city in which are located the offices of the ELECTRICAL REVIEW. When he was told that this building had a population of over 4,000 people and utilized over 1,000 horse-power for its electric elevator and lighting service, he expressed the utmost astonishment and immediately began a comparison of the conditions of a town of the same population in France. He also expressed himself with regard to the difference in engineering methods obtaining here and abroad. "Here," he said, "you go at things in the simplest, most obvious and direct way. If it is necessary to transport people quickly from one point to another, you build a railway, on the level if you can, overhead or underground, if you must; but you build it. And when it is built you put on it the simplest and most direct and powerful variety of motor and operate it with the most definite regard for the conditions it is to meet. This, to me," he said, "seems to be the distinguishing mark of American electrical engineering."

M. Leblanc will visit the great works at Schenectady and Pittsburgh before his return to France next week.

Storage Batteries Working Under Water.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

In the issue of the ELECTRICAL REVIEW of February 22 I note an item describing the operation of a storage battery working under water at the Municipal Electric Plant, Munich. It may interest you to know that this has occurred nearer home.

On December 11 last one of the city mains in front of the canal office of the Chicago Telephone Company burst, flooding the basement at that exchange. In the basement was installed all of the power apparatus, such as ringing generators, charging generators, power board, a storage battery of chloride accumulators, etc. The break in the main occurred at 5 A. M., and within twenty minutes the entire basement was flooded to a depth of about seven feet, entirely submerging the battery and cutting all of the other apparatus out of service. By eleven o'clock the water had been pumped out of the basement down to the battery. During the interval of six hours the entire office load was carried on the battery while it was under water. The Chicago Telephone Company connected up temporary batteries and had them ready to cut into service should they be needed, but they were not required.

CHARLES BLIZARD.

Philadelphia, February 25.

Association of Railway Telegraph Superintendents.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

Owing to free transportation restrictions on eastern lines the executive committee has, on vote of members, decided to change place of annual meeting of Association of Railway Telegraph Superintendents, June 18, 1902, from Boston to Chicago. Will you kindly make note of the fact in the ELECTRICAL REVIEW, and greatly oblige, yours truly,

R. W. DREW, Secretary.

Reminiscences from the First President of the National Electric Light Association.

An interesting letter from Mr. J. Frank Morrison, of Baltimore, the first president of the National Electric Light Association, was received by the ELECTRICAL REVIEW too late for inclusion in the Twentieth Anniversary Number for which it was intended. Mr. Morrison, who has been identified very prominently with electric lighting since its beginnings in this country, says:

"The telegraph, telephone and other electrical interests have looked to the ELECTRICAL REVIEW for support and encouragement as well as knowledge of current events, and have always received them, but the light and power industries owe it, and its editors, Messrs. Worthington and Price, a still greater debt, in that they were the pioneers in organizing the National Electric Light Association, which, rough-hewn in Chicago on February 25, 1885, stands to-day among the most useful of scientific organizations.

"During the lifetime of the ELECTRICAL REVIEW (twenty years) in telegraphy, we have had the process of evolution from the duplex, installed by D'Infreville in the old Bankers and Brokers Company's office, opposite the Stock Exchange in New York city in about 1869 or 1870, to the quadruplex, begun by Edison and completed by Joe Stearns and Gerritt Smith. You have the work of P. B. Delaney along broader lines, and finally the culmination of multiplex telegraphy by Professor Rowland, of Baltimore, which latter invention promises greater capacity than as at present used. I say nothing of Marconi. . . .

"In the telephone, nothing has taken the place of the carbon transmitter, which, as you know, made the Bell system practical and useful. Without it, unless we take into account the Edison button transmitter or something else as good, the telephone would, like some of our old accoustic telephones, have been only an interesting toy. The score of years past has produced the telephone exchange with all of its ingenious appurtenances, which are to-day looked upon as things which always were, and, last of all, the long-distance telephone. The expiration of the Bell patents opened up the commercial side of the business to competition, so that, at this date, independent telephone companies have found a home in almost every state. This has given a tremendous boom in the manufacture of telephones and telephonic appliances, one firm alone, in this city, having turned out nearly 10,000 equipments in 1901.

"From 1810 to 1877, a period of sixty-seven years, many of the greatest scientists of their day had given their best services to mankind in the endeavor to make the subtle fluid a servant. In this list appear the names of Davy, 1800; Foucault, 1844-1858; Wright, 1845; Starr, 1846; Staite, 1848; Archereau, 1849; Nolte, 1850; Roberts, 1852; Stator and Watson, 1854; Lacassagnac and Thiers in 1855, and Serrin in 1857. These were followed by Gramme, whose invention furnished the foundation of almost all subsequent electric generators. Then came a multitude eager to solve the problem of a 'division of lights,' as it was then called.

"Paul Jablochkoff (a Russian) in 1875, on his way to the Philadelphia Centennial Exposition, stopped at Paris and made the acquaintance of M. Breguet, who placed his laboratory at Jablochkoff's service. The result was, after eight months, that the invention known as the Jablochkoff candle was made. So great was the demand for an electric illuminant that in 1881 over 4,000 lamps with Jablochkoff candles were in use. Then the defects in the system began to show up and finally put it out of business.

"Tschikoleff followed with his lamp, in 1877, and claimed the first honor. While some of these had almost succeeded in solving the problem, yet it remained for Charles F. Brush, of Cleveland, to bring it to a practical and commercially successful issue. On April 24, 1877, his first patent, No. 189,997, was granted, after which, in quick succession, he was granted eighteen additional patents which completed what is known as the Brush system of electric lighting and solved the problem of series arc lighting, making it at once a commercial success, and furnishing the basic idea upon which all subsequent work and improvements in this line have been made.

"In 1881 apparatus was installed in Twenty-fifth street, New York, from which lower Broadway to the Battery was lighted. The first new station was erected the same year in Baltimore, after which companies were organized in all parts of the country.

"And then followed, in rapid succession, the inventions and improvements in apparatus which have finally resulted in the practical application of electricity to railways, with their vast power-houses containing plants costing millions of dollars, to stationary motor service ranging from fractional powers in the sewing-shop up to hundreds of horse-power in the machine-shop and mills, and the perfection and installation of the incandescent light, together with low-tension and enclosed arcs. The credit for this is due to Elihu Thomson more than any other single man.

"The phenomenal success which attended the Brush enterprise brought other inventors into the field, notably Elihu Thomson, Weston, Maxim, Schuyler, Fuller, Edison, Hochhausen and Arnoux, Jenney, Van Depoele and others. Companies were organized right and left, many of them in territory which gave no promise of earning money enough to pay running expenses much less to pay dividends on their hopeless issues of stock. Then, about 1892, the trouble began, but nerve and brains snatched victory from the jaws of defeat. The process of cleaning up began under the leadership of Mr. C. A. Coffin, of the Thomson-Houston company, who acquired the Edison, Brush and such of the minor manufacturing companies as were of any value, and made terms with the Westinghouse company; prices for apparatus were restored to their normal value; mushroom companies were weeded out, and the whole business placed upon a thoroughly sound commercial basis.

"There are to-day 2,950 central electric lighting plants having a combined capitalization of nearly $700,000,000.

"I have not space to treat of two epoch-making events as they deserve. The first and most important is the harnessing of Niagara Falls. The second is the application of the electric current to independent traction as exemplified in the automobile. In this electricity, waiting a lighter and more capacious storage battery, divides the honors with steam and gasoline.

"There is one thing that strikes me, and it must also be apparent to every close student of electrical progress; that is, that since the tendency to consolidation of companies and large capitalization there has been a dearth of invention. This is due, in my mind, to the fact that those who hold a comparative monopoly of all the present systems and devices consider it in the best interests of their clients and investors to frown down every new device or invention that they do not control, thus giving the independent inventor a harder road to travel.

"We are waiting for certain promises to be made good which will be a proper introduction to the new century—Edison's nickel and iron storage battery, Tesla's invention for the transmission of high-tension currents thousands of miles through a rarefied stratum of air which he finds four or five miles from the surface of the earth, Dr. William W. Jacque's 'carbon electric generator.' These and other blessings will likely reach us before we celebrate the next twentieth anniversary of the ELECTRICAL REVIEW."

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Decorations of the Metropolitan Opera House.

One of the heartily appreciated and most talked-of features in connection with the entertainment of the royal visitor in New York city last week was the utilization of incandescent lamps in combination with smilax and roses to produce very beautiful decorative effects. The remarkable display at the Metropolitan Opera House brought forth the unstinted compliments of the daily press in general.

In stringing the cables for carrying the lamps in the interior decoration, a great amount of work was done in a remarkably short space of time. The system manufactured by the International Electric Improvement Company (the "Elblight," which has been described in these columns), under the personal direction of Mr. Russell Spaulding, was used to carry out the interior effect of the decorations.

In the lobby and around the royal box hundreds of feet of twin cables were strung and twined through the Gobelin tapestry and over costly furnishings, and a thousand lights intermingled with smilax, without driving a tack and later taken up without bringing about any damage whatever to the property of the Metropolitan Opera House. The whole work of stringing this cable and inserting the lights consumed about one hour.

A very beautiful effect was produced in lighting the proscenium and a special drop-curtain. To a batten seventy-two feet in length were made fast a series of streamers of twin cables intertwined with smilax; upon this twin cable were myriads of frosted white and green incandescent lamps, each cable being lashed to the batten and having an individual cutout. Fourteen blocks and falls were used to raise this immense weight (nearly three tons) of cables, smilax and lamps to the highest part of the proscenium arch.

A drop-curtain was constructed of streamers of cables and smilax, upon which were fastened 3,000 small white and green incandescent lamps. At each intermission the heavy red curtain was dropped, and then behind this the cables containing the lights were dropped and the lamps lit up; then an opaque curtain was dropped behind the illuminated curtain and the red curtain raised; finally the opaque curtain was raised allowing the scenery to come into view behind the illuminated streamers. This extremely beautiful effect elicited round after round of applause.

Probably one of the most difficult parts of the installation was the hanging of the streamers from above the middle chandelier to the sides of the building; 1,500 lamps were used for this purpose, the cables being dropped from a panel-board above the ceiling, the ends being caught up at the sides. Below this was hung a festoon of smilax, and the glimmering lights shining through the green below produced a very beautiful effect. In connecting up this part of the work, a telephone was kept continually in circuit from the stage to the men working above the ceiling, each cable and its terminal having a systematic arrangement of numbers whereby the man on the floor could direct the workers above and keep in mind just exactly what was going on. The actual time consumed in installing the 4,500 lamps in the curtain and ceiling and the 3,000 in the proscenium arch was fourteen hours.

To carry the current for all this extra lighting, a separate series of cables were run in from the street and a temporary switchboard erected. Three separate feeders were connected up to each section, there being four sections in the proscenium and curtain; another section for the ceiling, and a separate section for the lobby and royal box. In all, 8,500 four-candle-power twenty-watt Edison lamps were used, giving a total of nearly 1,500 amperes in the lighting cables. During the whole work of the installation not a single lamp was lost nor was there a fuse blown, and from the beginning of the lighting to the last hour of its operation there was not a single defect discovered in any part of the lamp circuit.

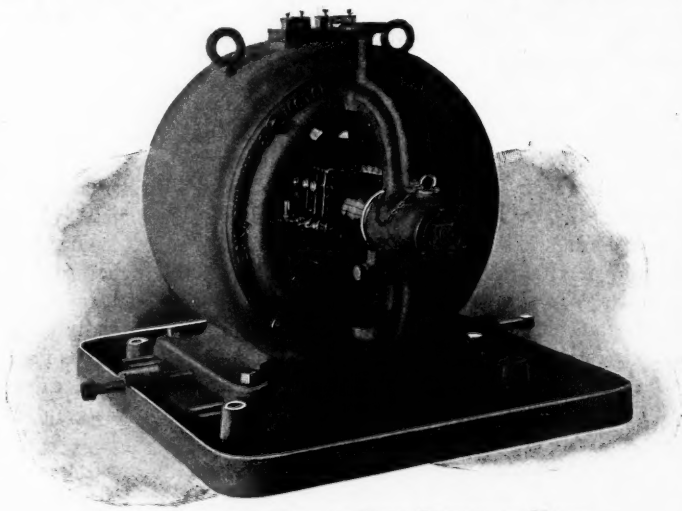


FIG. 1.—PROTECTED BIPOLAR TYPE DYNAMO OR MOTOR.

Protected Motors and Dynamos.

The Eck Dynamo and Motor Works, Belleville, N. J., produces a line of motors and dynamos which are designed with a view to their adaptability for all general use and to meet all conditions of general practice. In the illustrations are shown a few of the types of moderate and slow-speed protected semi-enclosed types of motors manufactured by this company. In Fig. 1 is shown a protected bipolar type dynamo or motor; Fig. 2 showing the same machine disassembled.

The field consists of circular yoke of such section as to secure the most efficient working and best circulation without being unduly heavy. The cores in one horse-power and over are of round, soft wrought iron, set deeply in the magnet frame, which is reenforced at this point to ensure a large contact surface and a perfect joint. The pole shoes are carefully shaped and securely mounted, the shape being such as to produce a uniformly distributed field in the air-gap, reducing the liability of sparking under varying conditions of load without shifting the brushes. The field cores are form wound, well insulated and held in place by the pole shoes. The armature is of the slotted or toothed type, built up of thin annealed sheet steel, possessing a high magnetic permeability. The armature is first baked to remove all moisture, then dipped in best armature varnish and again baked. The armature shaft is made

of steel of suitable hardness, turned and finished, 0.002 of an inch smaller than the sleeve at the bearing, after the core is put on to ensure perfect alignment. It is

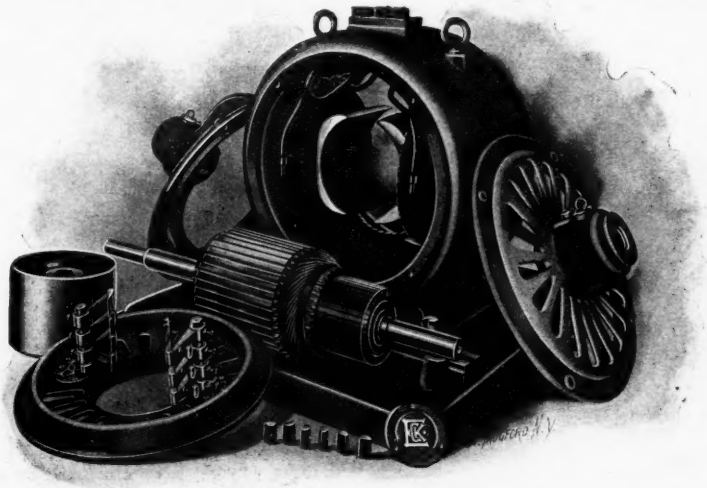


FIG. 2.—PROTECTED BIPOLAR TYPE DYNAMO OR MOTOR—DISASSEMBLED.

smaller at the pulley than at the bearing, which permits its turning down without refitting the pulley should the bearing become worn. The sleeve can also be slipped off without injury from burrs. The shaft is tapered at all points leading out from the bearings, the smaller part being outside, which prevents the oil from traveling on the shaft and being sprayed outside the bearings. The bearing sleeves are made of high-grade phosphor-bronze, self-aligning, and is provided with heavy oil rings, the oil reservoir being large and holding an ample supply of oil. The commutator is large and of great radial depth, being made of pure hardened copper, insulated with selected mica. The

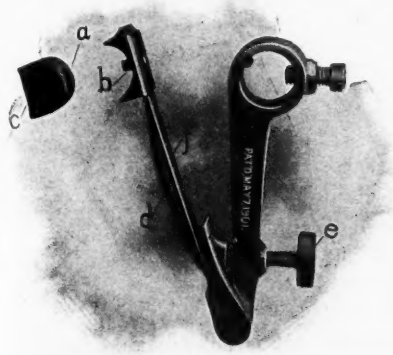


FIG. 3.—BRUSH AND BRUSH-HOLDER.

brush or rocker ring is large in diameter, fitted in a turned groove formed between the bearing bracket and the frame. It can be turned to permit adjusting the brushes when tested at the factory, but there is no handle, as no shifting is necessary from no-load to fifty per cent overload.

Fig. 3 shows the brush and brush-holder. The brush "a" fits into the curved holder "b," where it is allowed to turn slightly to adjust itself to the periphery of the commutator at point "c." The flat tempered steel spring "f" presses the brush-holder against the brush, the tension being adjusted by the screw "e," made so as to prevent it from turning through vibrations; two or more copper springs "d," running inside the steel spring carrying the current.

It is claimed, that owing to the high quality of material used and the great effort made to perfect proportioning of same, the efficiency of these machines averages from seventy-eight per cent in the one-quarter horse-power to eighty-seven per cent in the five horse-power, and the temperature elevation will not exceed forty-five degrees centigrade after ten hours running at full load. Each part of these machines is standardized so as to ensure interchangeability.

Fig. 4 shows a protected type of small motor or generator. These machines have the commutator and brush-holders exposed, giving opportunity for supervision and enabling the operator to detect excessive overloads through sparking at the brushes. The back bearing brackets are also provided with openings, permitting ventilation of the windings and securing cool running. The frame, armature, brush-holders and bearings are of the same design as in the Eck "Hurricane" fan motor.

A Report on Phono-Electric Wire.

Mr. Leonard Paget, a very well-known electrical engineer, of London, has recently made a very elaborate and complete report upon the peculiarities of phono-electric wire manufactured by the Bridgeport Brass Company for use in telephone signals. The subject is one of peculiar interest and at the same time of great difficulty. The new wire is of somewhat higher specific resistance than copper, but has advantages of great importance in connection with its mechanical strength and toughness and in the entire absence of any hard skin such as is found upon hard-drawn copper wires.

In the transmission of telephonic signals, the outer surface of the wire is a region of peculiar importance. In the masterly research of Dr. Pupin on "Telephone Transmission" it was clearly shown that the attenuation of telephone waves, while determined in some degree by the resistance of the circuit, is modified entirely by the other line constants and that the limit of telephony is set by the combination of the induction and capacity of a circuit rather than its resistance. The effect of resistance, however, is immensely modified when its distribution in the circuit is such that it affects one element or component of the complex telephonic wave more than another. For waves of the ordinary telephonic variety, the harmonics and overtones up to vibration frequencies of 2,800 to 3,000 cycles per second are important. In such waves transmission is affected particularly along the external skin of the conductor. On this account the skin effect is particularly important

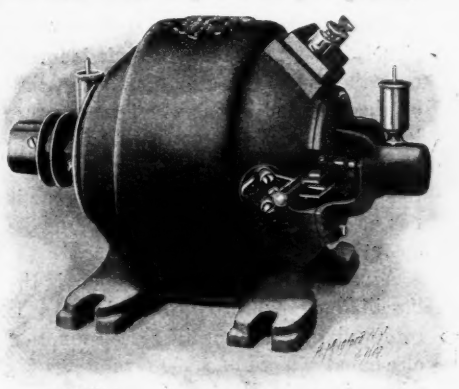


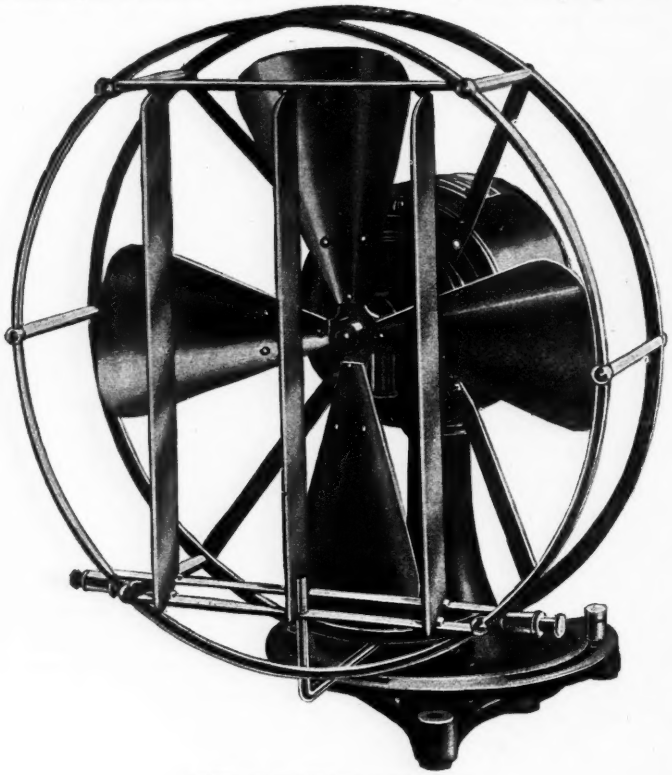
FIG. 4.—PROTECTED TYPE SMALL MOTOR OR DYNAMO.

and the homogeneity of the circuit is essential.

It is claimed that the results of practice exhibit that while a circuit constructed of this wire is of higher resistance than one employing hard-drawn copper wire, for example, yet both mechanical constants of strength, resistance to wind, vibration and sleet and general availability are better, while the absence of the hard and high-resisting skin of hard-drawn copper wire is noticeably evident in the extraordinary clearness of transmission attained.

The "Oscillating" Electric Fan.

The Shedd Electric and Manufacturing Company, New York city, manufactures the "Comfort Oscillating" electric fan. It is claimed that the peculiar construction of this type of electric fan makes it very desirable and efficient. This fan is so constructed that a stream of cold air is forced over the fields and armature, preventing overheating and burnouts. The armature lead wires are carefully protected by a cap from dampness and injury. It is claimed that the half-inch square resistance bar is not affected by moisture or heat, and its operative efficiency is very high.



"Comfort Oscillating" Fan.

A particular feature of this fan is the "oscillator" guard with which it is equipped. With an ordinary consumption of current a speed of 2,400 revolutions per minute is attained. This "oscillator" guard causes the entire motor and fan to swing slowly about on a pivoted base to whatever extent may be desired, the powerful breeze generated at this speed being split up and distributed over a wide range of space. The motor is light, artistic and durable in construction.

"Armalac"—A New Insulating Material.

The Massachusetts Chemical Company, manufacturer of Armalac in various forms, has produced a very interesting pamphlet entitled "How to Insulate an Armature." Armalac is a compound possessing high insulating qualities and not subject to deterioration by acids, oxygen or ozone, while lubricating oils are stated not to affect either its insulation resistance or its chemical permanence. It is also entirely water-proof.

The method of insulation recommended by the company in connection with this compound is that the armature laminations should be dipped into armalac thinned with petroleum naphtha to such a point that it leaves a film not over one one-thousandth of an inch thick upon an object dipped in it. In plants where a large amount of work is handled the laminations may be painted with this compound by running them between printers' rollers, one of which runs in a trough of the compound. It is not necessary to bake the laminations, as they dry completely in a few moments.

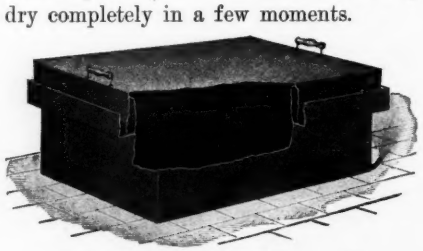


Fig. 2.—Tank for "Armalac."

Armature coils should be wound up without tape or fibre and temporarily kept in shape with lead clips. In this condition they should be baked for an hour in an oven at not over 150 degrees Fahrenheit. The object of baking is to drive out all moisture, but a longer period is not necessary as the long-continued exposure to heat deteriorates the fibre of the cotton insulation.

Taking the hot coils from the oven and without allowing them to cool immersing them in a bath of armalac is the next step in the process. The coils should be allowed to cool completely in the bath and then hung up to drip for five minutes. At the end of this time they should be reversed so as to dry with a thick even coat. They should not be baked. The accompanying illustration of a dripping tank which can be made by any tinsmith is suggested by the company as an excellent variety of tank. The outside trough should be kept half full of lubricating oil which forms a vapor-tight joint.

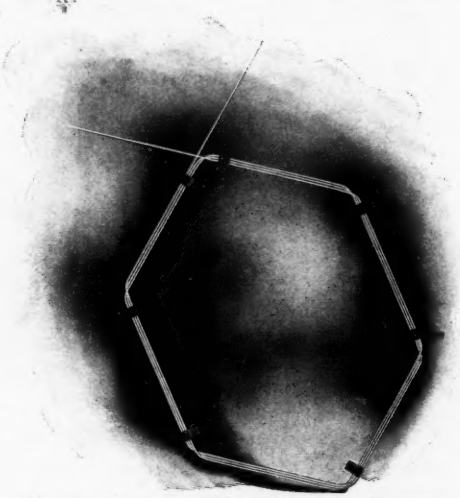


Fig. 1.—Armature Coil Ready for Dipping.

After the portion of the coils intended to go into the slots of the armature are taped they are heated for fifteen minutes to cement the compound of the first dripping to the tape, and then while it is hot are again dropped quickly into the tank of compound. It is not necessary to allow them to cool in the tank this time, the object of this dipping being to close pinholes and air-spaces in the tape-winding.

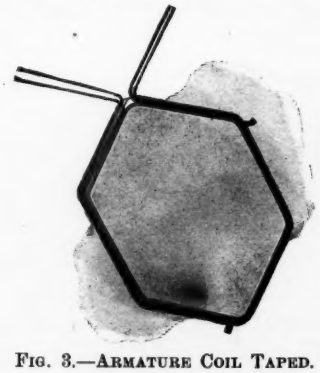


Fig. 3.—Armature Coil Taped.

It is claimed by the company that for quick repair work short-circuited armature coils may be placed with those treated as described above, and that then the armature may be heated by a current for a few minutes until it is quite hot, then it may be taken out of the fields and put on horses

and turned over and over again in a shallow wooden box containing enough armalac to give it a thorough soaking. It should be allowed to drip about fifteen minutes, still turning slowly, and then put back in the machine. It can be started up at once slowly and with no load, and

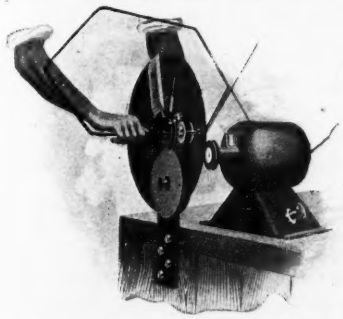


Fig. 4.—Machine for Applying Tape.

the load should of course be put on slowly. It is claimed, however, that a 150-horse-power armature may safely be brought up to full load and speed in an hour and will not throw out enough insulation to cause any trouble. One of the illustrations shows an ingenious machine for winding armalac tape by power.

Another illustration shows an ingenious and valuable machine made by the Detroit Street Railway's Reinsulator Company for removing the insulation from the wire of old field coils, straightening and reinsulating the wire in an operation, thus effecting a saving of from $2 to $5 for each field. The machine draws the wire from the old coil, and after straightening it and removing the old insulation completely reinsulates the wire before it is wound into the new field with hardly any increase in time and labor over that consumed in winding fields with new wire. The insulating material used is a cloth tape with friction compound on one side. Armalac is generously applied as the new coil is wound. This machine is in successful operation with many of the larger street railway companies.

Convention of Automobile Clubs.

A joint invitation, signed by the Automobile Club of America, the Philadelphia Automobile Club, the Long Island Automobile Club, the Rhode Island Automobile Club and the Chicago Automobile Club, has been issued to all active clubs, to be represented by two delegates, to a convention to be held in the rooms of the Chicago Automobile Club, Coliseum Building, Chicago, March 3 and 4.

The contemplated premises for organization are, briefly, that all regularly constituted and active automobile clubs of acceptable repute be eligible to membership in an interdependent federation on an equitable basis of representation in all deliberative matters.

Views, News and Interviews.

Mr. Thomas A. Edison and family have gone to Florida, where the distinguished inventor will spend a month fishing and resting. Mr. Edison's newest work—the storage battery—has shown satisfactory results from every test so far made. The new factory, in which there is being installed considerable specially constructed machinery, is nearing completion, and it is believed that the electromobile market will begin to receive the batteries by April of this year.

"The change from steam to electricity on the elevated roads of this city will not be a boon to the hat manufacturers," remarked a New Yorker recently, flicking a piece of oily cinder from his beaver. "I have had two hats ruined in as many years by a splash of oil falling on them from an overhead engine. Others in numbers must have had the same experience. We shall all bless the day when the electric motor supplants the steam engine—except the dealers in hats."

"At first I wondered where the electrical men of the day were to be found when I read Mayor Low's list of eminent gentlemen to welcome Prince Henry," said a prominent electrical engineer. "They certainly were not to be found there, and yet Germany is probably next to the United States in research in electrical science and is just now foremost

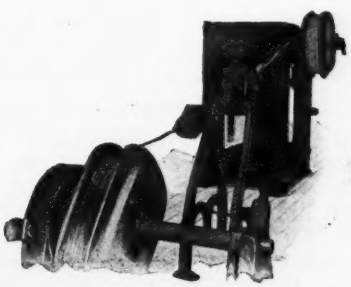


Fig. 5.—Machine for Reinsulating Field Coil Wire.

in electric traction experiments. This oversight, however, I see was well remedied in the list of 'Captains of Industry,' that met to do honor to the Prussian Prince."

William Stanley, of Great Barrington, Mass., the electrical inventor, is now sojourning in Europe, and will remain abroad until April. Mr. Stanley is said to be interested in automobile development, and will thoroughly investigate European conditions before returning.

William J. Bell.

Mr. William J. Bell, Baraboo, Wis., is widely known throughout the Northwest, having been actively engaged in the electrical business for the past twenty-two years. Mr. Bell is prominently identified with the independent interests in this section of the country, and is the head of the Bell Telephone Manufacturing Company, of Baraboo; he is also a member of the executive committee of the Wisconsin Independent Telephone Association.

Mr. Bell is not only well known as a business man, but has devised numerous novelties in the telephone field, one being a patent telephone directory which works upon rollers and springs after the fashion of a window shade, and is placed in the battery box or cabinet receptacle outside the telephone; upon a comparatively small space six or eight hundred names may be placed. This has proved a very convenient and efficient device.

Mr. Bell is now constructing a plant in competition to the Bell in New Decatur, Ala. At different times he has been called as an expert before medical bodies. He has organized many companies, all of which have been financial successes.

Liberty's Torch.

For the first time in fifteen years, since it was installed, the electric light torch on the statue of Liberty in New York Harbor has ceased to glow. It is understood, however, that this is only temporary, resulting in the change of the management of the lighting of the statue from the Navy to the War Department.

It will be remembered by the electrical people that the contract for supplying the machinery for this light was awarded to a company of which Mr. Edwards H. Goff, now deceased, was at that time president, and Mr. Goff, with commendable generosity, donated the lighting plant to the government.

Minerals in the Urals.

"According to a statement of the mining department," writes Consul Smith from Moscow, Russia, "the production of minerals in the Ural district for 1901 was: Gold, 570 poods (2,052 pounds); platinum, 380 poods (1,368 pounds); coal, 30,000,000 poods (500,000 tons). All the above figures show a decrease in comparison with 1900, and the metallurgical branch has also fallen off. The copper industry seems to be advancing, as several new works have been opened up for the production of this metal."

Notes from Great Britain.

(By Our Special Correspondent.)

ON the first week of the new year—to be correct on the first Saturday and Sunday—a series of explosions in electric lighting cable vaults and surface boxes occurred in London, in that part of the city which is now served by two competing electric supply companies. One of these companies, the Charing Cross & City Company, has its network of mains laid for the most part on a solid system, while the City of London Electric Lighting Company has, from the first, adopted the "draw-in" system. Inasmuch as the explosions in question were directly traceable to an accumulation of bituminous gas in the respective surface boxes, the problem set for solution is the possibility of such vapors finding their way into the conduits of the City company. This is what has been alleged by Mr. Frank Bailey, their engineer, on the one hand, while Mr. W. H. Patchell, the Charing Cross Company's engineer, states that there is no engineering reason for him to consider that the explosions in his competitor's boxes were in any way due to those in his own, mindful of the fact that they happened simultaneously and that he admits that bituminous vapor was generated in his cable vault in the first instance. Altogether there were four explosions on the Saturday afternoon within a few minutes of each other and also within sight of each other, and one in the early hours of the Sunday morning, a state of affairs so unusual that the Board of Trade were prompted to hold an enquiry into the cause but a few days afterward. At this enquiry the following facts were brought to light which, summarized briefly, amount to this. Seeing by the power station ammeters that an excess of current was coming on, evidently the result of a short-circuit somewhere, the Charing Cross people set about locating the trouble and succeeded in tracing it to a certain section. Wishing to disconnect that section from the system temporarily, a lamp was lowered into the cable vault for the purpose of ascertaining the atmospheric or gaseous conditions which prevailed. An explosion immediately followed, and within a few minutes the covers of some neighboring surface boxes belonging to another company were blown into the air. Then some twelve hours afterward a similar surface box belonging to the City of London Company was wrecked in a similarly mysterious manner, and the task before the electrical adviser to the Board of Trade, who presided over the enquiry, is to say to what extent the later explosions were due to the earlier one and to evolve some means for preventing the occurrence of such things again happening.

The much anticipated and discussed government debate on the agreements entered into recently between the Postmaster-General and the National Telephone Company has duly taken place and practically we stand where we were. After a good deal of hostile criticism from both sides of the House, the voting on the motion for a general and immediate enquiry resolved itself into a party question, pure and simple, and a large majority was against this course. By the terms of the agreements in question either party in the transaction may urge a modification or otherwise in the present subscription rates, etc., and with a full knowledge of this fact a magnanimous Secretary to the Treasury promised a periodical enquiry into the general conditions prevailing, the first of such enquiries, however, taking place at the end of five years. Sir Joseph Dimsdale, the Lord Mayor, who introduced into the House the motion for an immediate enquiry, was so satisfied with this assurance that, had he had only himself to please in the matter, he would have withdrawn the said motion after having made a speech in which the Post Office usual official stoicism was greatly emphasized. However, the matter has to rest where it is at present, although it is to be feared that the feelings of the average Englishman are slightly mixed over the whole affair.

The question of tube railways is very much in evidence again, and principally due to the fact that something like two dozen such bills for London are now awaiting settlement, an effort was recently made in the House of Lords to get last year's joint committee on tube railways reformed. Thanks are to be offered up that the attempt was unsuccessful, as the sole results of this particular committee's labors last session were to hang up all the bills they dealt with until this session.

Apropos of the electrification of the now famous Inner Circle, this happy state of affairs is not proceeding with the harmony suggested in the willingness with which both companies accepted the arbitrator's award in favor of the continuous-current system. The main trouble seems to be in connection with the supply of the current, and a little controversy is going on as to whether it would be more economical for the District company (Mr. Yerkes's) to supply power to the Metropolitan company, or for the latter concern to erect its own generating station. Although from the statements on the side of the District company doubt seems to exist, a pretty clear idea of the attitude of the directors of the Metropolitan company is given in the statement in its half-yearly report to December last that tenders for the equipment of its power-house will be let among a number of firms which have tendered for the work which they anticipate will be completed in eighteen months. On the other hand, the District company is said to have ordered forty-eight B. & W. boilers in addition to several Westinghouse turbo-generators.

Meanwhile, the Central London Railway, as chief competitor to the Circle, goes on increasing its number of passengers and the amount of its profits. The average number of passengers carried per month during the last six months of 1901 was 3,467,108 as compared with 2,983,384 during the final five months of 1900. During the December half of last year a total of 20,802,650 passengers were carried. The company's bill now in Parliament endeavoring to complete its present line into what will be practically a circle inside the "Inner Circle" will still more seriously aggravate the traffic of the Metropolitan and District companies, and strenuous opposition from that quarter may be looked for when the bill reaches the committee stage.

The usefulness and efficiency of the electrical engineer volunteers in South Africa are amply demonstrated by a call by the War Office for a sixth detachment to proceed to the front.

The breaking up of the London streets first by one authority and another for various telegraphic, telephonic and electric lighting purposes, has proved such an intolerable nuisance that attention has been called to the matter in Parliament. It is really satisfactory to learn that negotiations are in progress between the London County Council and the various London borough councils, with the object of securing powers which would authorize the former as the central controlling body.

February 19. A. W.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

ROME TO NAPLES ELECTRIC RAILWAY—The Allgemeine Electricitats Gesellschaft, of Berlin, is said to be negotiating with the Italian Government with a view to undertaking the concession for the construction of the projected electric railway to be operated between Rome and Naples.

RUSSIAN RAILWAYS—New lines are projected or are now in course of construction in Russia, to the extent of 5,681 versts, involving an estimated capital outlay of 420,304,897 roubles. The length of the great Trans-Siberian line is 7,783 versts; the expenditure made by this undertaking on capital account has thus far been 780,000,000 roubles, but it is estimated that this total will have to be carried to at least 850,000,000 roubles.

NEW FIRE ALARM TELEGRAPH FOR CINCINNATI—A bill appropriating $150,000 for the installation of a new fire alarm telegraph service has been drawn by the corporation counsel at the request of the board of fire trustees, and will be presented to the Hamilton County delegation. A complete underground system is contemplated, which will be extended to all the recently annexed villages. The service in the outlying territory is very poor, Clifton, Avondale and Linwood still retaining the old village systems. A new fire alarm telegraph headquarters will also be built, if the bill secures passage.

ELECTRICAL NEWS FROM RUSSIA—The Kishtim Works, in the Ural Mountains, Russia, will have installed early this year an electrical plant with motors of 3,000-volt capacity, fed by gasoline engines, to run a lighting plant, a plant for the electrical reduction of ores, an electrical ore-crushing plant, and also a plant to run an electric mining railway. The power station is already under construction. It is stated that the mining department of the Imperial Russian Ministry of Agriculture is sending Mr. Shapirer, an expert in electrical engineering, abroad to study electrical engineering adapted for mining purposes, and to visit mines where such machinery is in operation. Mr. Shapirer will visit Germany, Belgium, France and Austria.

BUFFALO RAILWAY MERGER—A certificate of consolidation of the Buffalo Railway, Buffalo & Niagara Falls Electric Railway, Buffalo, Tonawanda & Niagara Falls Electric Railway, Niagara Falls & Suspension Bridge Railway, Buffalo & Lockport Railway, Lockport & Olcott Railway and the Niagara Falls Suspension Bridge Company, forming the International Railway Company, of Buffalo, has been filed with the Secretary of State. The capital of the International Railway Company is $10,120,500, and the directors are: Francis Lynde Stetson, Joseph P. Ord, Daniel S. Lamont, Charles Steele and Daniel O'Day, of New York city; W. Caryl Ely, Burt Van Horn, Elliot C. McDougal, Henry J. Pierce, Henry M. Watson and Robert L. Fryer, of Buffalo; William B. Rankin, of Niagara Falls, and Thomas Dewitt Cuyler, of Philadelphia.

TELEPHONE EXTENSIONS—At the annual meeting of the stockholders of the Pacific States Telephone and Telegraph Company, held in Portland, Ore., expenditures were authorized for extensions to the lines of the company and for other improvements, which aggregate $2,100,000. Plans were considered and approved for improvements to the local system and for enlarging the building occupied here by the company. This has been made necessary by the large increase in volume of business transacted in Portland. New multiple switchboards will be installed in connection with the local system, at a cost of $30,000, and new copper trunk lines will be established between Portland and San Francisco, Blaine, Wash., and Northport, Wash., the last-named place being directly north of Spokane on the Canadian border, where connection is made with the system in British Columbia.

TENDERS WANTED IN GREAT BRITAIN—The East Ham Urban (England) District Council is prepared to receive tenders for the supply and erection of the following: Section A—One 500-kilowatt continuous-current multipolar generator, direct-connected to an 800 indicated horse-power horizontal cross-compound slow-speed engine; extension of switchboard. Section B—Two water-tube boilers, condenser, feed pump, steam and exhaust piping and cooling tower. Parties tendering are at liberty to bid for either of the sections, but not for a part only of either section. Copies of specifications, with general conditions and form of tender, may be obtained on application to the engineer and manager, W. C. Ullmann, M. I. E. E., Electricity Works, Nelson street, East Ham, England, on payment of the sum of three pounds sterling, which will be returned on receipt of a bona fide tender.

ELECTRIC LIGHTING

ST. PAUL, MINN.—The board of aldermen has passed an ordinance granting to F. C. Genge and others a franchise for a lighting and heating plant at St. Anthony Park. The company has one year in which to complete a suitable plant.

DOYLESTOWN, PA.—The Doylestown Electric Company is about to increase its plant by the substitution of new machinery throughout. The capital of the company has been increased from $25,000 to $35,000, much of this increase to be expended in improvements.

RICHMOND, VA.—A company to be known as the Emporia Light and Power Company has been organized here. It intends to establish an electric light plant and ice factory. This company will also take in the local telephone line, consolidating the three enterprises and running them under the one general management.

LANCASTER, PA.—A charter has been granted to the Lancaster Valley Electric Light Company, having a capital of $60,000. The company has bought the electric light plants at Manheim, Ephrata and Mt. Joy, and will operate the system from the central plant with Elton W. Lucas, of Philadelphia, as superintendent.

WORTHINGTON, IND.—The Indiana Water and Light plant has been sold to the American Light and Water Company, of Indianapolis, which took possession February 1. The sale was made through Mr. A. M. Barron, of Chicago. The same gentleman is now negotiating for the purchase of the electric light and gas plant at Baraboo, Wis.

BINGHAMTON, N. Y.—Negotiations have been completed whereby there will be an absorption of the Broome County Electric Company by the Light, Heat and Power Company. The new company also purchases the plant of the Binghamton General Electric Company, and the three concerns will, in the future, be operated under the management of the one general company.

PERSONAL MENTION

MR. WALTER CAREY, vice-president of the Milwaukee Electric Company, Milwaukee, Wis., has been in New York for several days.

MR. A. A. THRESHER, president of the Thresher Electric Company, Dayton, Ohio, is making his headquarters at his New York office for a few days.

MR. MORRIS MEAD, president of the International Association of Municipal Electricians, and the chief of the electrical department of the city of Pittsburgh, Pa., was in New York last week.

LIEUTENANT F. P. BADT, formerly of the Prussian army, now a resident of Chicago, distinguished in electrical engineering circles, was a New York visitor last week. Lieutenant Badt has recently recovered from a severe illness.

MR. CHAS. SELDEN, superintendent of telegraph of the Baltimore & Ohio Railroad, was a New York visitor last week. Mr. Selden is one of the pioneer telegraph men of the country and was the founder of the Association of Railway Telegraph Superintendents.

M. MAURICE LEBLANC, one of the most famous electrical engineers of France, Officer of the Legion of Honor, member of the Société Internationals des Ingenieurs Electriciens, and associated with M. Hutin in some of the most important developments of alternating-current electrical engineering practice that have been made, was last week a visitor in New York for a few days. At the meeting of the American Institute of Electrical Engineers last Friday, M. Leblanc was invited to a seat on the platform with President Steinmetz, and on the following day was entertained at luncheon by several gentlemen of the electrical engineering profession in New York city.

TELEPHONE AND TELEGRAPH

MEDFORD, N. J.—The Interstate Telephone Company is building a new line from here to Marlton.

CORBIN, KY.—The East Tennessee Telephone Company has purchased of A. W. Francis the franchise he recently bought of the town.

LA PORTE CITY, IOWA—The new telephone system is in working order and lines are rapidly being contracted for the outside towns around.

NORTH TONAWANDA, N. Y.—The Bell Telephone Company, of Buffalo, has been granted a franchise for the term of fifty years by the board of aldermen.

SEATTLE, WASH.—The Seattle Electric Company has applied to the city council for permission to construct a new line on Eighteenth avenue and adjoining streets.

BLOOMINGTON, ILL.—The Gibson Telephone Company has been granted permission to lay 3,100 feet of cable underground, the work to commence in the near future. Plans are being drawn for a fine brick building to be used for telephone exchange.

NAVASTOTA, TEX.—The Independent Telephone Company is stringing wires to fill up the gap between Navastota, Bryan and Hempstead. When completed this will give Navastota competitive long-distance telephone service to the principal cities of Texas.

OKLAHOMA CITY, OKLA.—A company has been organized at Oklahoma City and chartered, known as the Automatic Telephone and Supply Company. Its purpose is to buy, sell and lease telephone lines and companies in the Indian Territory, Oklahoma and Texas.

MACON, GA.—Emil Dorrs, a prominent capitalist and manufacturer of Chicago, has applied to the city of Macon for franchise to establish a telephone system in Macon for the purpose of operating a local exchange and long-distance toll lines out of Macon, connecting with the surrounding cities.

ASHLAND, ORE.—Ashland is to be the eastern terminus of the new telephone system which is to run into East Oregon through Klamath and Lake counties and into Modoc County, Cal. Work is to be commenced on this construction and equipment as soon as possible, and it is to be in operation by August 1.

MILWAUKEE, WIS.—Manager H. W. Hamlin, of the American District Telegraph Company, of Milwaukee, explains the proposed increase of the capital stock from $100,000 to $200,000 by the needs of the company in extending its service. The company's business has grown so that a larger capital will be necessary to conduct it.

MINNEAPOLIS, MINN.—The Northwest Telephone Exchange Company will make some extensive improvements in Minnesota and North and South Dakato during the coming season. Central exchange buildings will be erected at St. Cloud, Fargo, Winona and Grand Forks. These and other improvements will amount to $500,000.

NASHVILLE, IND.—The Nashville Telephone System has passed into the hands of the Morgantown Telephone Company. This transfer of stock will bring the Morgantown and Columbus lines into competition at this place, both having a switchboard in common. The Morgantown company promises to extend its lines throughout the county.

MOLINE, ILL.—Telephonic communication between Moline and the upper end of the county is about to be established on the basis of toll rates of five cents a minute. The Central Union has met the proposition of the Crescent Telephone Company, the independent line, by a proposition to connect with the independent and charge toll rates. This will probably be accepted.

NORTH YAKIMA, WASH.—The telephone company is extending its lines up the valleys tributary to this part of the Yakima Valley and is greatly increasing its list of city and rural subscribers. The Ahthanum and Naches valleys are to be included in the circuit, as well as the Nob Hill and Wide Hollow countries and the lower part of the Sunnyside Valley known as Outlook.

WHATCOM, WASH.—M. E. Williams, the local manager of the Sunset Telephone and Telegraph Company, has just received a notice from the company's head offices in San Francisco that work will begin at once reconstructing the line between the Bay cities. New cables will be installed and the express system placed in both towns. About ninety days will be required to do the work, and the improvement will cost $15,000.

SAN FRANCISCO, CAL.—Approval of the $25,000 bond of M. Adrian King having been given by the council, immediate steps will be taken for utilizing the franchise for a new telephone system lately awarded to him. That Mr. King has connections thoroughly able to install a modern telephone exchange and to provide facilities for communication to all subscribers is believed by persons who have noted his eagerness for the acquirement of a franchise.

AUBURN, N. Y.—At the recent meeting of the board of directors of the Empire State Telephone and Telegraph Company, it was decided to move the headquarters to Syracuse. Directors were elected as follows: Frederick P. Fish, of Boston; Joseph P. Davis, of Boston; Thomas Sherwin, of Boston; C. J. French, of Boston; Jeffries Wyman, of Boston; George Underwood, of Auburn; H. L. Storke, of Auburn; C. I. Avery, of Auburn, and F. G. Fincke, of Utica.

BROOKLYN, N. Y.—The linemen employed by the New York & New Jersey Telephone Company, whose field of operation covers Long Island, including the boroughs of Brooklyn and Queens and the northern part of the state of New Jersey, took advantage of the demand for their services occasioned by the recent sleet-storm and struck last week. About seventy of the men of the New York Telephone Company also went on strike at the same time.

NEW INCORPORATIONS

HARRISBURG, PA.—Electric Light, Steam, Heat and Power Company. $1,000.

ALBANY, N. Y.—The Oneonta Light and Power Company, of Oneonta, Otsego County. $175,000.

JEFFERSON CITY, MO.—The Missouri & Kansas Telephone Company filed a statement of increase of capital from $2,500,000 to $5,000,000.

INDIANAPOLIS, IND.—Falmouth Mutual Telephone Company. $5,000. Directors: Daniel Lewis, W. H. Baker, Cary Jackson, Leroy Saxon and Van Wood.

INDIANAPOLIS, IND.—Home Telephone Company, Syracuse. Capital, $25,000. Directors: J. T. B. Kauffman, G. D. Lint, A. A. Rasor and William Self.

LANSING, MICH.—Delray Electric Light and Power Company, Delray; $10,000. Scott Security Company, Virginia, Minn., and Mass City, Mich.; $50,000.

ST. PAUL, MINN.—The Central Minnesota Telephone Company, of Willmar, recently filed amended articles of incorporation with the Secretary of State, increasing the capital stock of the company from $100,000 to $300,000.

MUNCIE, IND.—The Delaware & Madison Counties Telephone Company. $500,000. To operate in Muncie, Anderson, Elwood, Alexandria and other cities and towns in Madison and Delaware counties. The stock is divided into shares of $100 each.

MORRISTOWN, PA.—Montgomery Telephone Company. $5,000. Directors: John H. Schultz, Norristown; E. Mayhew Michener, North Wales; Jacob W. Brunner, Belfry; Daniel M. Anders, Fairview Village; B. Witman Damley, Skippack; Abraham K. Dresher, Worcester, and Amos Schultz, Worcester.

OTTAWA, ILL.—Joliet, Newark & Western Electric Railroad Company. $10,000. Incorporators: J. A. Henry, Joliet, E. C. Bronk, Joliet; A. S. Halbert, Newark; J. N. Dearinger, Chicago; M. H. Wallace, Chicago; L. B. Springer, Chicago; J. B. McCullock, Chicago; G. P. Tritze, Chicago; C. H. Talcraft, Joliet; J. W. Silk, Chicago; Ed. Stoelsee, Chicago.

BUFFALO, N. Y.—Buffalo, Springville & Cattaraugus Railway Company. $1,000,000. Directors: Henry L. Moench, of Boston, Mass.; Loren F. Bores, of Buffalo; S. F. Bruger, of Cattaraugus; W. A. Oakes, of Cattaraugus; U. L. Upson, of Buffalo; G. A. Matteson and C. H. Mason, of East Otto; F. X. Weber, of Boston; W. J. Hayes, of Buffalo, and T. P. Truby, of Otto.

CAMBRIDGE, OHIO—The Cambridge & Byesville Traction Company has been incorporated with a capital stock of $500,000. The object of this company is to build and operate an electric street car line through the streets of Cambridge and to connect this city with Byesville. Some time ago the company was granted franchises for the road by both the Cambridge and Byesville city councils. This company will be known as "The Consolidated Company," and will take over all interests of the Consolidated Ice and Electric Company.

ELECTRICAL SECURITIES

A gradual narrowing of speculation, ending with a dull and featureless session of the closing day, marked the condition of affairs in the market of last week. It appears as if the bear element was being strengthened with the dwindling in the volume of business.

The recent decision of the United States Supreme Court in refusing to entertain the motion of the Minnesota authorities to bring action against the Northern Securities Company was not unexpected. It had little market effect, however, owing to the fact that a new suit on different grounds is the order of the Federal authorities. As there are persistent rumors that it is the intention of the Federal law authorities to institute proceedings against other industrial consolidations much anxiety is evident, and a quick means of gaining a decision in this case is sought. It is not likely, however, that a decision will be rendered for some time, as the case will, in all probability, have to proceed through the usual courts of Federal jurisdiction.

A renewal of gold exports to the amount of $3,500,000 last week has attracted much attention, and monetary conditions have increased in influence as speculative factors of late. This is the normal season for gold shipments and, as conditions are improving abroad and easy rates prevailing at all important foreign centres, it is hoped that the demand may cease and the gold shipments will soon be on a small scale. The recent British successes in Africa, and the freer working of the South African mines have also bolstered conditions on the London market.

ELECTRICAL SECURITIES FOR WEEK ENDING MARCH 1.

New York:	Closing.
Brooklyn R. T.	64
Con. Gas	218½
Gen. Elec	295
Man. El	132½
Met. St. Ry	168¾
Kings Co. Elec	193
N. Y. & N. J. Tel. Co	168
Telep., Tel. & Cbl. Co	5

The annual meetings of the stockholders of the Kings County Electric Light and Power Company and of the Edison Electric Illuminating Company have been held and these directors reelected to serve for the ensuing year in both corporations: A. N. Brady, N. F. Brady, William Berri, Charles Cooper, Felix Campbell, Horace C. Duval, Walton Ferguson, Bernard Gallagher, Hugh J. Grant, Seth L. Keeney, T. E. Murray, W. F. Sheehan and A. M. Young.

The showing for traction companies was fairly good. Metropolitan showed a surplus after charges of $992,822, against $947,914, allowing in each year for other income. There is still opposition to the plans for the lease of the Metropolitan Street Railway to the Metropolitan Securities Company.

Boston:	Closing.
Am. Telep. & Tel	155½
Edison Elec	255
Erie Tel	21
New Eng. Tel	140
Mass. Elec. pf	96¼
Westing. Mfg. pf	90
Western Telephone & Telegraph	95

Philadelphia:	Closing.
Elec. Co. of America	7
Philadelphia Elec	6¼
Union Traction	40½
United G. I. Co	120¼
Elec. Stor. Bat. c	63
Elec. Stor. Bat. pf	65

It has been stated that the Electric Storage Battery Company, of Philadelphia, has practically acquired control of the Pennsylvania Electric Vehicle Company through the purchase of its stock.

The capitalization of the Consolidated Traction Company, the new company which is to lease the Union Traction Company, is to be $30,000,000, in 600,000 shares of a par value of $50. The lease will run for 999 years. Union Traction stockholders will have the right to subscribe for one share of new stock in proportion to each four of present holdings.

Chicago:	Closing.
Central Union Tel	40
Chicago Edison Light	166
Chicago Telep	185
Metropolitan El. pf	89½
National Carbon	20½
National Carbon pf	84
Union Traction	14¼
Union Traction pf	47½

Official announcement has been made of the proposed increase of ten per cent in the stock of the Chicago Edison Company. The directors have passed a resolution authorizing the issue of $690,000 additional stock to be offered at par to holders of record April 22 in the ratio of one share of new stock for each ten of their then holdings. Subscriptions for the new shares with payment in full must be received by the treasurer on or before May 1. The resolution provides that "subscriptions for fractional parts of one share shall when paid be represented by fractional subscription receipts, carrying no participation in dividends nor in voting power, but exchangeable in amounts equal to whole shares for regular stock certificates."

ELECTRIC RAILWAYS

FINDLAY, OHIO—Announcement has been made here of the formation of a company of New York capitalists to build an electric line from this city to Defiance, a distance of sixty miles.

OSKALOOSA, IOWA—The city council has granted the right of way to the Oskaloosa & Tama company through the town to construct an electric line from Tama to Buxton.

HUNTINGTON, L. I.—The question of a cross-island trolley from Huntington to Babylon is again being agitated. The route suggested is by way of Deer Park, West Deer Park, Pine Lawn, Melville and West Hills.

ANDERSON, IND.—The directors of the Muncie & Greenfield Electric road recently held a meeting at which time contracts were discussed and voted to be let immediately. The work of grading the road-bed will commence as soon as weather permits.

CLEVELAND, OHIO—At a recent meeting of the board of control, a communication was received from John B. Hoefgen, asking for permission to go ahead and construct the three-cent fare street railway over the routes proposed. The matter has been referred to the city council.

LAUREL, MD.—The Laurel City Council has granted the Berwyn & Laurel Electric Railway the right of way through the town. This syndicate, it is understood, has also secured control of the city and suburban railway of Washington, which runs between that city and Berwyn.

GRAND RAPIDS, MICH.—The Grand Rapids, Holland & Lake Michigan Rapid Transit Company has increased its capital stock from $500,000 to $1,000,000. Superintendent Stanley says that the increase means that the company will add largely to its equipments for the coming summer business.

MARION, IND.—The recent consolidation of the Toledo & Bryan Avenue Line Company and the Ohio & Indiana Traction Company gives the latter a continuous right of way from Toledo, Ohio, to Marion, Ind., a distance of 157 miles; the headquarters of the new company continues to be at Fort Wayne.

WESTMINSTER, MD.—A company has been formed in Hagerstown to complete a trolley road, to cost $300,000, from Hagerstown to Antietam Paper Mills, Chewsville, Cavetown, Smithsburg and Ringgold, Md., and Rouzerville, Waynesboro and Pen-Mar, Pa. The road will be twenty-two or twenty-five miles long.

BEAUMONT, TEX.—The electric railway line to the oil fields, which was begun last year and abandoned after a franchise had been secured and a few blocks of rail laid, will now, it is promised, be completed as rapidly as possible. A big force of men has begun work and it is expected that the construction will be completed by early spring.

GRAND RAPIDS, MICH.—The plans of the Grand Rapids, Grand Haven & Muskegon Electric Line have been materially changed. Instead of coming into Lansing from Detroit it has been decided to extend the Jackson line to Lansing, then go as originally planned from Lansing to this city. Work will begin as early as possible in the spring.

MCKEESPORT, PA.—Negotiations for the transfer of the interests of the Greensburg & Southern Trolley Company and the Westmoreland Electric Company to the Pittsburgh, McKeesport & Connellsville Trolley Company are about completed. The consideration in the deal is said to be $750,000. It is also said that the local telephone company is included in the deal.

NORWOOD, OHIO—The Cincinnati Traction Company has been granted permission by the council to make changes in the overhead system of the South Norwood line. In order to secure more power for this line, a feed wire will be brought from the Eastern avenue station by the Torrence road to Fairfield avenue, to Bolce avenue, Hyde Park, and from thence over the Norfolk & Western Railroad into South Norwood.

INDUSTRIAL ITEMS

THE RENIM SPECIALTY COMPANY, Boston, Mass., is now occupying its new quarters at 176 Federal street.

J. JONES & SON, 64 Cortlandt street, New York, is the eastern agent for the Colonial ceiling and desk fan motors.

THE AMERICAN CIRCULAR LOOM COMPANY, Chelsea, Mass., is sending reminders to friends in the form of a complete smoker's outfit.

THE C. H. LEVER MANUFACTURING COMPANY, Chicago, has perfected a new device known as an anchor or toggle bolt for electric light construction work.

THE ALPHA ELECTRICAL CONSTRUCTION COMPANY, 29 Gold street, New York, has recently established new shops for repairing electrical instruments and apparatus.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburgh, Pa., is issuing Bulletin No. 8, in pamphlet form, describing and illustrating its different types in a treatise on the "Ultimate Efficiency of Transformers."

THE ELECTRIC APPLIANCE COMPANY, Chicago, selling agent for the Sangamo Electric Company, has just published a most complete meter catalogue or book of information, dealing with the Gutmann integrating alternating-current wattmeter. It will be sent upon application to those interested.

THE BAIRD MANUFACTURING COMPANY, Chicago, Ill., is meeting with great success with its electric clock-switch. The company is the recipient of some strong testimonials, one from Charles E. Graves & Company, jewelers, the firm which secured the first switch, being particularly gratifying.

ROSSITER, MACGOVERN & COMPANY, New York city, electrical and steam machinery, is distributing a very attractive calendar in colors that are vivid and of a striking design. Bold lettering proclaims that this company does repair work, refilling commutators, rewinding armatures, and assembling segments.

THE STANDARD UNDERGROUND CABLE COMPANY announces that its Boston offices are located at No. 101 Milk street (Converse Building), where it will be glad to see and hear from its friends who have favored the company to such a gratifying and substantial extent, that it finds this change of quarters a necessary condition.

THE CUTTER ELECTRICAL AND MANUFACTURING COMPANY, Philadelphia, Pa., is working upon a very popular advertising scheme. The company is announcing the distribution of a half a million postals among its customers. Each postal card bears a small illustration of some type of the apparatus manufactured, together with some catchy phrase in small type, and leaving plenty of space on the card for other use.

MESSRS. W. R. OSTRANDER & COMPANY, New York, have just brought out the thirteenth edition of their revised catalogue of electric fittings and apparatus, telephone and telegraph instruments, electric lighting material and general electrical supplies, speaking-tube hardware and electricians' tools, etc. The catalogue is a handsome book of 300 pages, elaborately illustrated and very complete.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is prepared to send upon application circulars fully describing the loud-ringing extension bell which it is selling. This bell is especially desirable for telephone service where the instrument is placed in factories and other noisy places. It is mounted on hardwood base with nickel-plated trimmings which makes it adaptable for use in offices where a bell of neat appearance is desired.

THE GOULD STORAGE BATTERY COMPANY, New York, N. Y., has just completed an installation at Easton, Pa., for the Easton Power Company, which is a subcompany of the Light, Heat and Power Corporation, of Boston, Mass. This plant consists of 255 cells of Type S 611, in lead-lined tanks, having a capacity of 408 kilowatt-hours, and a Gould patented counter electro-motive-force regulating booster. This equipment is to be used in regulating the fluctuations of the street railway load, and replaces a plant of half its size.

THE STERLING ELECTRIC COMPANY, La Fayette, Ind., reports a continued heavy demand for telephone apparatus, and it is said that this company has been running for many months to its fullest capacity in the production of its complete line of telephone instruments, switchboards and equipment for the full common battery system. The personnel of this company has recently undergone a change, inasmuch as Mr. Frank B. Cook has sold his interest in the company to a syndicate managed by Messrs. Taylor and Remy, both of Indiana. Mr. W. E. Doolittle will be president, and H. S. Bullock, general manager. It is announced that the company will pay Mr. Cook a royalty on his patents.

WESTINGHOUSE, CHURCH, KERR & COMPANY has secured an order from the Lackawanna Iron and Steel Company for a complete equipment of Roney mechanical stokers for its Lebanon, Pa., plant. This order, together with one for the Buffalo plant, aggregates thirty-four 250 horse-power, or 8,500 horse-power of Roney stokers ordered by this concern within the last ninety days. The large power plant of William Walton Dunnell, at Apponaug, R. I., will be fitted up with stokers of this pattern, and the Standard Steel Car Company's power plant, at Pittsburgh, has also adopted them. Recent orders for Roney mechanical stokers include equipments of electric lighting, street railway and power stations, manufacturing plants of every description, and of large and small capacity.

THE VARLEY DUPLEX MAGNET COMPANY, Phillipsdale, R. I., is sending out to the trade its 1902 catalogue containing a lot of new matter on the subject of electromagnets. Some recent and valuable improvements in core-making machinery have made it possible for the Varley company to put up its windings in the form of complete the magnets a wider field. The catalogue is for the cores and washers, thereby giving the magnets a wider field. The catalogue is complete in every detail and a very large variety of telephone magnets is shown together with instructions for computing the cost of any magnet containing a lot of variable factors. Catalogue also contains useful bare and insulated wire tables taken from "The Electromagnet" by Wolcott, Kennelly and Varley, and is mailed free on application.

THE STUART-HOWLAND COMPANY, Boston, Mass., reports a remarkable growth in all departments of its business. Sales in the last year show an increase of 120 per cent over the previous year. The street railway department has been particularly prosperous, having furnished in the season of 1901, in addition to general supply business, the entire overhead and pole equipment (excepting wire) for over 500 miles of new road. The company now manufactures this complete line, and has already several large orders booked for delivery the coming spring. This company carries a complete stock (except heavy machinery) and has recently issued a 332-page, six inches by eight inches, general electrical supply catalogue, handsomely bound in cloth, in which everything is listed alphabetically, and very generally illustrated.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has just issued Bulletin No. 18, describing the electrical equipment of the Joseph Dixon Crucible Company, of Jersey City. This company which formerly operated four separate steam plants has now combined them into one electric power plant. A 100-kilowatt generator and twenty-four motors, all of Crocker-Wheeler manufacture, have already been installed, and future equipment is contemplated. The company reports that the outlook at the end of the first month of the new year is most promising, both in present orders coming in and in the indications for a heavy spring business. Among the January shipments may be noted the following: De Lamar Copper Refining Company, Carteret, N. J., one 520-kilowatt generator, one 100-kilowatt generator, one 50-kilowatt generator; Iron City Engineering Company, Uniontown, Pa., four 100-kilowatt generators; Anglo-American Provident Company, seven motors ranging from ten to seventy-five horse-power; Pennsylvania Steel Casting Company, Chester, Pa., one 350-kilowatt generator; Quintard Iron Works, New York city, one 65-kilowatt generator; Marine Engineering and Machine Company, Harrison, N. J., two size 111, 50-kilowatt generators, one 60-horse-power motor, two 35-horse-power motors; United States Electric Lighting Company, Washington, D. C., one 90-kilowatt generator, one 130-horse-power motor; National Tube Company, Pittsburgh, Pa., one 110-kilowatt generator; Niles Tool Works, Hannibal, Ohio, a consignment of motors; Erie Rapid Transit Railway, Harbor Creek, Pa., one 200-kilowatt generator; L. S. & M. S. Railway shops, Collinwood, Ohio, one 400-kilowatt generator, one 75-kilowatt generator; Mechanical Laboratory, Lehigh University, South Bethlehem, Pa., one 30-kilowatt generator; American Car and Foundry Company, Madison, Ill., one 110-kilowatt generator; Armour Fertilizer Works, Atlanta, Ga., one 150-kilowatt generator, two 50-horse-power motors, one 90-horse-power motor; Park Steel Company, Pittsburgh, Pa., one 200-kilowatt generator; J. K. Farley Manufacturing Company, Chicago, Ill., one 150-kilowatt generator; Fort Hill Chemical Company, Rumford Falls, Me., four 140-kilowatt generators.